M.G. Jackson

# Towards A New Educational Protocol

## Beyond Greening and Examination Reform in School Education

PERMANENT GREEN

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***M. G. Jackson***

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***For my grandchildren***

***Aditi, Nidhi, Meghna, and Sean***

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# *Preface*

In this book I will outline a new system of school education. This endeavour has been prompted by the recognition of the following three general problems that are common to all schools and curricula in India today.

1. School curricula all have an upper-income class, urban bias.
2. They fail to address in an effective way the problems of global warming, environmental destruction, loss of community, violent conflicts over limited natural resources (land, water, forests, minerals and oil), financial instability, and persistent poverty.
3. The learning process in all schools is largely one of transferring pre-determined concepts and packages of information from teacher and textbook to student.

I will endeavour to explain why I think these features of our current educational provision are problems, why they are generally not recognised as problems, and, to the extent they are recognised as problems, why they are not being addressed effectively. My central argument is that these problems cannot be solved by piecemeal reforms, but only by rethinking our whole approach to education at a fundamental level. When this is done rigorously, an entirely new way of educating our children begins to emerge.

The upper-income class, urban bias of mainstream school education is a problem because what children are expected to learn in school is entirely unrelated to the lived experience of the children of rural and urban poor families, which together constitute an overwhelming majority of school-going children, actual and potential. What children are expected to learn reflects and seeks to promote the large-scale, urban-centred model of industrial development adopted after Independence. This bias has been further strengthened by the economic liberalisation policy adopted in the 1990s. The media and parents offer children a vision of their future as compliant employees in global business and a consumerist life style in an urban setting. The school curriculum reinforces this vision by convincing children that what they learn in school is the passport to this future. For a majority of children, however, this vision turns out to be a mirage. Further, they do not gain the knowledge, concepts and skills to help them create and live a life of economic security and dignity within the fabric of national life.

School curricula in India as everywhere else reflect and perpetuate the European so-called Enlightenment worldview which sees human beings as separate from and independent of their natural surroundings, having an unquestioned right to use natural resources in whatever way they think will lead to their greater material comfort. Further, it delegitimizes all pre-enlightenment ways of thinking and acting and those of all non-European cultures. The global problems we now face are clear indication that this worldview is inadequate – and, indeed self-defeating in the long run. Mainstream thinking has yet to face up to this fact and so it is not surprising that formal education has failed to address these problems in any effective manner. What is not understood is that any serious effort to address these problems will require a shift in worldview – in those responsible for formal education and in society as a whole.

The learning process as understood today derives its rationale from the basic concept of a person which is a part of this same Enlightenment worldview, and is likewise inadequate – to say the least. That concept

is of a person as a complex mechanical system, or more specifically a computer which must be loaded with programmes (concepts) and data (information). This accounts for the 'teach-and-test' pedagogical model that prevails today, a model that ensures that classroom learning is a superficial and painful experience for children. Here again, a shift in worldview holds out the hope for an alternative model, one that might transform the classroom scene.

The new system of school education, deriving its legitimacy from an alternative worldview, is designed to:

1. meet the needs of children who live in rural India and who may never be able to live in an urban setting with dignity and economic security, offering them a vision of a viable, fulfilling future where they are;
2. meet the needs of children whose families live at the margins of urban life, offering them also a vision of a viable future for themselves in an urban setting in which they are not marginalised;
3. embody and project an alternative worldview, what will here be termed the 'living systems' view, in which human beings must strive to ensure the health of the natural and human-made systems in which they are embedded
4. at the same time, it will enable all children to take an informed and active part in the larger life of the nation and the world;
5. bring into use new modes of learning, based on the conception of 'learning by reflecting on experience,' to help accomplish the fore-going (items 1-4);
6. free the learning process from the excessive structuring that characterises present-day formal school education.

The system will be described in general terms. It is flexible and can be tailored to suit specific local conditions and needs.

The term 'greening' in the title of this book is used in its contemporary sense to include all the efforts that are being made to address the

problems of global warming, environmental degradation, social disintegration, violent conflicts over land, water, forests, oil and minerals, financial instability and persistent poverty. The unstated assumption underlying this greening agenda is that the model of contemporary global culture, a model focused almost exclusively on economic growth through increasing industrial production need not be questioned. All that is needed is some 'fine-tuning' or minor 'course corrections' to deal with these unfortunate 'side-effects' of growth.

All the indicators designed to measure the health of social, economic and environmental systems, however, are worsening – and at accelerating rates. It seems to me that a point has been reached where it is necessary to recall that useful axiom that when a problem defies solution, and instead gets worse or ramifies, in spite of all our efforts, it is a good idea to stop, back up and question our basic concepts. A few people, myself included, in fact reached this point years ago and have been suggesting such a return to the basic concepts of our collective worldview – to all those concepts that legitimise our obsession with economic growth. When this is done rigorously, serious flaws are revealed. Some of these concepts are found to be ambiguous or evasive. Collectively they do not 'hang together', or in other words our system of concepts, as a system, is incoherent.[1] These flaws result in our dysfunctional cultural model, a model that harbours the seeds of insensitivity, greed and violence. [2]

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1. A worldview is a system of basic (or primary) concepts in terms of which we construct a mental picture of the world. Such a picture is unique to each person, but all pictures in a given culture and cultural era are similar in their main features. The term 'adequate' in this definition means that the worldview is reasonably effective as a basis for organizing our individual and collective lives on this planet. Examples of basic concepts are definitions of: 1) the ultimate, actual elements of our experience; 2) life; 3) time; 4) space; 5) causation; 6) the person; and 7) knowing (Jackson, 2008, p. 29). These definitions are assumptions; they are not facts but intuitive preferences.

2. 'A cultural model is a set of secondary concepts derived from the primary concepts of its supporting worldview. The model of contemporary global culture, for example, mandates "competition"

With an alternative worldview, clearly articulated, we begin to see that existing problems in a new light; some of them even disappear. In short, we are well on our way to being able to formulate an alternative cultural model.

It is my experience that a good way to approach the task of formulating an alternative cultural model is by way of a consideration of present-day non-mainstream activities, programmes. By 'non-mainstream' I mean activities and programmes which are successfully dealing with problems that are intractable from the point of view of the cultural model of contemporary global culture. Examples of this are alternative systems of farming, health care, education, science and local governance. We ask ourselves: what are the basic concepts in terms of which these activities and programmes make sense? In articulating these we do not necessarily have to begin from scratch. A little reflection will reveal that the concepts we are groping for are not new, but have appeared, in essence, in earlier civilisations and cultural eras – often more than once. We also soon discover another remarkable fact, namely that there is a convergence of the basic concepts of all these contemporary non-mainstream activities, programmes and theories. The same basic concepts are operating in all. This simplifies our task since it allows us to start from that particular activity or programme which we know best, and to which we are already committed. At the same time we have the assurance that we are participating in a broad, general cultural transformation.

These non-mainstream activities, programmes and theories all pre-suppose what is being termed the 'living systems' worldview. In this view all things, even the simplest, are assumed to be living entities. They are thus sentient, active and intelligent beings. This concept was common in all cultures and ages, as far as can be determined from the historical record, except for that of the modern West. The philosophers

---

and the "pursuit of happiness" (that is, the pursuit of pleasure). These are secondary concepts about the nature of the relationships among individuals, derived from the primary concept of the nature of the individual person (Ibid., p. 30).'

and scientists of the European Enlightenment decisively discarded this concept and instead assumed that all simple entities are passive lumps of material substance acted upon by external forces. They were non-living, dead. What is called life, they said, and present-day philosophers and scientist still say, is 'merely' an epiphenomenon of certain very large and complex aggregates of such dead entities, or that life 'spontaneously emerges' in physical entities on their reaching a certain level of complexity. The logical discontinuity in this assertion is obvious: how can something that is non-living spontaneously become living? This is only one instance of the waffling that is necessary to sustain the worldview of contemporary global culture. Other instances will come to our attention in due course.

All entities in the new worldview are seen as systems of parts, or smaller entities, and are themselves parts of larger systems. Further, four kinds of entities or systems are recognised: physical, thought, emotion, and feeling (sensation). In the enlightenment worldview the only 'real', ultimate entities are physical. Thoughts, emotions and sensations are, again, said to be 'only' epiphenomena of large, complex aggregates of small material (that is, physical) entities. The dominant metaphor for this way of thinking is that of a machine. In the living systems view, the metaphor is of an organism.

To summarise, greening of the school curriculum assumes that fine tuning or reforming it is all that is required. With a sound cultural model this assumption is valid. But when the cultural model and its underlying worldview of any society are dysfunctional this assumption is not valid. Fine tuning and reform only make the situation worse, throwing up even more symptoms of the underlying dysfunction. At such times a transformative agenda involving a return to basic concepts is required. Today is such a time.

The term 'examination reform' in the title of the book makes it clear that our intention in respect of the school system is to reform it. The problems generated by our 'teach and test' approach to school education, however, are symptoms of an inadequate conception of the

learning process. It is necessary, therefore, to go back to square one: what are the concepts on which our present understanding of the learning process is based? The way in which we understand this process determines the way we try to evaluate its outcome. The key concept is, to phrase the matter rather bluntly, that the child is an empty receptacle. Into this receptacle, the present-day system of education, at all levels, seeks to pour as much information as possible. Changing the metaphor, the child is also like a new computer which we programme concepts and skills and load with data.

If we assume the empty receptacle concept of education, then our learning outcome evaluation procedures must be quantitative. We must ascertain how many of the concepts and how much of the information have been poured in have been retained. All efforts at examination reform have not succeeded in removing the stress or lessening the trauma that present-day examinations cause to young people. Only with a complete transformation of the system will the 'problem' of examinations be overcome. In fact, with a different definition of learning, as I hope to make clear, the problem simply disappears.

In the living systems worldview a distinction is made between knowing and understanding. All things (entities or systems), whatever their type, are directly cognised. Such knowing is direct and indubitable. What is known, however is meaningless unless it is placed in some known context – that is, seen as part of a known (that is, previously cognised) system. When it is seen thus, it acquires meaning, or, in other words is understood. Understanding is a thought thing and is similarly indubitable. However, this understanding may not be appropriate. A person may understand a given fact in more than one way, and different people may understand it differently, depending on their prior understanding of the things they have cognised. The concepts that make up a person's worldview are the ultimate contexts for his or her understanding.

In a word, learning is to be seen as an active process in which the learner creates knowledge and understanding for himself or herself.

With the dawning of understanding, a person changes, evolves, literally becomes a different person.

In terms of learning strategy in the new educational system, the child is exposed to a clear, logical and coherent worldview in all teaching and learning transactions (the living systems worldview). He or she is asked to 'make sense' of the facts that he or she experiences on his or her own, or, in other words, create appropriate contexts. Ready-made contexts are not handed out. Similarly, children are required, as far as possible, to generate, by means of specific activities, facts on their own. Facts are not handed out to them. If they successfully do all this they will have learned. There is no need to evaluate their learning in terms of what they have learned, but only how they have responded to the learning process to which they are exposed. This is a qualitative assessment made by the person who is facilitating that process. In doing this he or she will be mindful of the child's strong points and of the possibility that he himself or she herself, or the programme in general, have not been able to capture a particular child's imagination and attention fully. There should be no finality about the facilitator's assessment.

The word 'protocol' in the title is to be understood as a set of general guidelines for designing and conducting a programme in any given field of interest. The guidelines derive from an explicit set of basic concepts that constitute a worldview shared by all theorists and practitioners in the field. In this book I will describe a new protocol for school education.

Two important components of the worldview that underlie the new protocol and legitimise it are the living systems concept and the concept that learning is a creative process. They will be described more fully in Chapters 2 and 3. The essential differences between the worldview of contemporary global culture and this new worldview are highlighted. I will give my reasons for abandoning the former and adopting the latter. The merits of the new programme I will describe should be judged on the robustness of the alternative worldview it presupposes and on how well it has been able to give practical shape to its several concepts.

The new system of education presented in this book is a system, an inter-locking set of concepts and practices which can lead to definite and useful learning outcomes. As with all systems, natural or human-made, this system cannot be created all in one go; it can only evolve once it is set in motion. What its final form will be, no one can say at the beginning. In fact, there will never be a final outcome since, like all living systems, this new educational system will continuously evolve. All we can do is to initiate the process by setting out clearly the concepts we are deploying, a broad strategy for achieving definite learning outcomes, and various tactical methods that we think will facilitate the achievement of that strategic goal. We (learning facilitators, administrators and planners) will learn as we go along.

I visualise a number of groups, formal or informal, agreeing to undertake this new programme in a variety of situations and then pooling their experience and making improvements in light of that experience. At some point in the future the system may be thought to be sufficiently developed to be introduced more widely.

This process will take some time. Meanwhile, we can anticipate analogous developments in higher education and in other areas, and that our efforts will dovetail with those of others, moving the process of cultural transformation forward on an ever-widening front.

Dr. Lalit Pande, Director of the UEEC has given me permission to include here a slightly edited version of Chapter 1 of UEEC monograph entitled *Environmental Education in India: A Critical Assessment of Developments To Date and Suggestions for the Future* (UEEC, 2000) that appears in Chapter 1 of this book. I originally wrote Chapters 2 and 3 for Nyla Coelho's book Our Land Our Life: A curriculum for children of rural communities in India (Coelho, 2012). She has given me permission to include them in this book. They have been extensively revised. Similarly, I wrote Box 1.1 for the same book, and Nyla has given me permission to reproduce it here. They have been extensively revised.

I am indebted to Mrs Veena Sirohi, Director, Educational Resources Centre, Cambridge Schools, New Delhi, for her interest in this book project, and her help and encouragement.

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M. G. Jackson

# 1 The Classroom Scene Today

The purpose of all education, in its broadest sense, is the perpetuation of the cultural model of the society in which it takes place. This is natural and appropriate. But there are times in history, in as far as we are able to discern and interpret the historical record, when an existent cultural model becomes dysfunctional and counter-productive. At such times it becomes necessary, if the society is to survive, to discard the existent model and formulate an alternative. With a new model, protocols governing all aspects of life, including education, must also be formulated. Collectively, these new protocols ensure that the new model is established and stabilised. The central argument of this book is that contemporary global society has reached a point where its present cultural model must be abandoned, and a new model created.[1]

In the field of school education the need for a new protocol is not generally perceived. This accounts for the persistence of the greening and examination reform policies. The failure of these policies is also not seen, or, if seen, not acknowledged. In this chapter I propose to present evidence for their failure by looking critically at what is happening in the classroom. In subsequent chapters I will show how an alternative approach

1. For a comprehensive and in-depth treatment of this topic, see Jackson, 2008.

to formulating school educational programmes, following an altogether different protocol can obviate the need for greening and examination reform. It is easier to admit that a programme or policy has failed if a clear alternative is visible.

## *Whose perspective?*

With the whole-hearted adoption of the Western-style development model some two-decades ago average household income has increased and also the availability of goods and services. These benefits have not, however, been shared equally by all of us. Urban middle and upper-income groups have benefitted most, while people in rural areas and those who have migrated from rural areas to cities have benefitted very little. Indeed, many of these people have been further marginalised.

The people who formulate educational policies, build curricula and write textbooks are members of the urban middle- and upper-income groups. They are understandably the most committed to the perpetuating of this development model, and are the least likely to question it, or to give the marginalisation and down-right suffering of a majority more than a passing nod. Their outlook informs our entire educational provision. This provision is largely meaningless to children in rural areas and those in urban slums since it does not place the learning programme in those children's immediate lived environment. This is in spite of the declaration of the National Curriculum Framework of 2005 (NCERT, 2005) which insists that the children's life at school must be linked to their life outside the school. The textbooks prepared after 2005, however, indicate a failure to recognise that there are many different lives outside the school; urban affluent, rural, and urban marginalised.

For a majority of the children in our schools what they are expected to learn in school is meaningless. This majority learn that the only way to 'get on' is to memorise what is being offered. This is an example of what I termed 'negative learning'. It is no more than a survival strategy in a hostile world, and so has its value. Is this, however, our aim in educating children? Equally damaging, it seems to me, is that the current

provision subtly confirms children of middle and upper-income group urban families in their belief of their superior status vis-a-vis children from rural and marginalised urban families, and confirms children of marginalised rural and urban slum families in their acceptance of their inferior status. Here is a second example of 'negative learning'. Is this upper-income urban bias justified? On what grounds can it be justified?

To come to specifics, a few extracts from current NCERT textbooks (NCERT, 2006-2009) of science for grades 6 to 10 are offered below, each followed by a few comments.

1. In the science textbook for grade 7, in a Chapter entitled 'Wastewater Story', on page 220, it is written:

> Clean water that is fit for use is unfortunately not available to all. It has been reported that more than one billion of our fellow human beings have no access to safe drinking water. This accounts for a large number of water-related diseases and even deaths. Women and girls walk for several kilometres to collect clean water, as you read in Chapter 16. Is it not a serious matter for human dignity?

It is not difficult to make out by whom this was written, nor for whom. Why have the words 'our fellow human beings' in the second sentence been used instead of the word 'us'? Then there is the phrase 'it has been reported': which children do not know this that it must be 'reported' for them to come to know it? If some children do not know it, will simply telling them do any good? Will the appeal to them to understand the denial of human dignity to those of their classmates who must carry water do any good?

2. In the 6th grade science textbook, in a chapter on garbage (or trash or rubbish) and how to deal with it, we read (p. 161):

> You might have seen some children sorting garbage near your house or at other places. Observe the children at work and find out how they separate useful material from the garbage. They are actually helping us. Talk to one such child and find out:

> what do they do with the rubbish they collect? Where do they take it? Does he or she go to school? What about his or her friends? If they do not go to school, find out the possible reasons. Can you help this child to read and write?

Here again it is clear who has written this and for whom. Further there is a patronising note. Some children from families whose occupation is the sorting of this trash are now being enrolled in our schools, government and private, and it is our collective hope that more will be in the future. Consider how this will sound to them. Why should there not also be an exercise to investigate the behaviour of children of upper and middle-class families who create most of the waste and who fail to contribute to its effective processing? Are they making a positive contribution to society, as, according to the textbook, slum children who collect and sort rubbish are ('They are actually helping us.')? Of course, it is not a question of blaming 'others' for our collective problems, but coming to see for ourselves, and helping our children to see, that we are all caught up in a defective cultural model.

3. In the science textbook for class 7 in the chapter entitled 'Forests: Our Lifeline' there is a story of a visit to a forest by a class of students (pp. 206-8):

> One Sunday morning the children...walked together through a forest trail near a village. On the way they met Tibu, a young boy of their age group, of nearby village, who was taking cattle for grazing along with his aunt....When he saw the children, Tibu...started walking along with them, while his aunt went on a different path. As soon as they entered the forest Tibu raised his hand and signalled them to keep quiet because noise could disturb the animals living in the forest.

The story goes on to tell about the animals and trees the children saw. Seeing these things, 'Boojho and Paheli remembered that they have studied about forests as an example of a habitat in class 6. They could see now how the forest provides a home for many animals and plants.' The text then goes on to describe the inter-relationships of plants, soil and decomposers in a forest.

For the children of the class this story describes a nature study outing, conforming to the urban upper and middle class conception of environmental studies. Tibu is a nature study guide. A village child like Tibu, however, will see his village forest as a vital part of his family's and village's livelihood base, and will be concerned about today's grazing and a supply of fuelwood and cut fodder. He, of course, knows the animals and trees of the forest. He needs to learn the ecosystem concept as applied to the forest and his whole village and how to ensure sustainable production of the things his family needs. But this is not covered in the textbooks anywhere. This lesson is more or less meaningless to him. It is probably meaningless also to slum children. What is needed is a strategy by which all children, wherever they live and whatever their families do for a living, come to understand the varied life situations of all their contemporaries and how all these life situations are inter-related, parts of a single social, economic national-world system. If we are convinced that the system is sick, then it is our collective responsibility to heal it. School education must create the capacity and willingness in all students to take on this task.

NCERT social sciences textbooks for grades 6 to 10 are more sensitive to this issue. The textbook Social and Political Life for grade 6 for example, has a section of local government and administration with separate chapters on rural administration and urban administration, and also a section on livelihoods with separate chapters on rural and urban livelihoods.

## *Contradiction, incoherence and confusion in the classroom*

In the year 2000 G. P. Pande, a colleague in the Uttarakhand Environmental Education Centre (UEEC), and I prepared a monograph *Environmental Education in India; A Critical Assessment of Developments to Date and Suggestions for the Future* (UEEC, 2000).The first chapter was an enquiry into the effects of the national policy on greening the school curriculum. This policy was formulated by the National Council

of Educational Research and Training (see NCERT, 1988) and was implemented in the new editions of the Council's model textbooks that were issued from 1987 to 1989 (NCERT, 1987-89). In accordance with this policy, environmental concerns were 'infused' into existing subjects, primarily science. The guidelines of the 1977 Inter-Government Conference held in Tbilisi were followed in this approach. This exercise was very *ad hoc* in that additional sections or chapters on environmental problems were simply inserted in new editions of the Council's textbooks. In articulating these problems the Council's textbook writers were also guided by Western, urban-centric perceptions of what constitutes environmental problems.

The objective of the monograph was to assess critically what had been achieved by this exercise. As far as we knew no one had tried to assess the extent to which this infusion exercise had succeeded in improving children's awareness of environmental problems, in changing their attitudes, in providing them with clear-cut conceptual basis for action, or in providing them the skills needed to successfully tackle environmental problems. Casual observations led us to conclude that there was an increase in awareness of some of these problems, but nothing more. A critical analysis of the infused textbooks themselves, however, lead us to the conclusion that nothing more than this could have been expected. Earlier, Krishna Kumar found that the infusion exercise was introducing contradictions and incoherence in the classroom (Kumar, 1996). Following his lead we documented this phenomenon more fully. Further study in connection with the writing of this book reveals that the same infusion policy has continued to be pursued till now. What follows in this section is an updated version of our report of 2000.There has recently been some attempt on the part of textbook writers to define environmental problems in terms of an Indian context.

### *The problem of pesticide use*

An example of the contradictions and incoherence being created in the curriculum by the infusion of environmental concerns is the use of pesticides in agriculture and public health programmes. In Appendix 1 a selection of statements from the NCERT textbooks of environmental

science and biology on the subject of synthetic chemical pesticide use is presented.

The 5th grade textbook presents a stark contradiction: the student is told that pesticides are a serious threat to people's health, and also that he/ she should spray DDT regularly in his or her house to kill mosquitoes. An ineffectual attempt is made to remove this contradiction by saying that we must learn to use science and technology with great care and understanding. The statement 'take care that it is not sprayed in excess' is presumably intended as an example of using science and technology with great care and understanding. It implies that 'large' doses are harmful while 'small' doses are not, but does not define either of these terms. Thus, far from clearing up the basic contradiction, this treatment only adds confusion.

The message that pesticides are harmful to human health is stated more explicitly in the 8th grade textbook, and in the 9th grade textbook their indispensability to food production is stated as a matter of fact. Further, in the 12th grade textbook it is explained that even small repeated doses of DDT are accumulated in the human body, thus making the earlier solution proposed – spray regularly, though not in 'excess' – completely untenable. Finally, in the 12th grade textbook a more determined attempt is made to remove the initial contradiction by describing integrated pest management (IPM). But this is really only an elaboration of the earlier advice to '...use science and technology with great care and understanding', and similarly fails because even IPM advocates the spraying of pesticides.

In the last analysis the children are made aware of the environmental problem of pesticide use but is offered no solution to it, except for the vague hope held out in the 9th grade textbook that scientists might invent pesticides that kill only insects and are biodegradable. This sentiment is consistent with the often expressed view in the textbooks that environmental problems created by current technologies can be solved by the development of improved technologies.

A real solution does, however, begin to suggest itself in the 12th grade textbook: the discontinuance of pesticide use altogether. Children

are told convincingly that pesticide use is counterproductive and that it is possible to farm organically without the use of any chemical pesticides. If this were done the problem of pesticide toxicity to animals and human beings would disappear. The textbook authors do not, however, explicitly say this. To do so would flatly contradict the 'green revolution' farming protocol that figures so prominently in the rest of the textbook. Instead they waffle: they extol organic farming which does not use pesticides while continuing to advocate their use for controlling pests and raising food production. Their presentation is incoherent.

The authors also point out that traditional farming was done without chemical pesticides. In fact, they admit that 'Scientists are realising that "traditional" does not mean "backward" and that … [scientists] have much to learn from farmers.'

The authors do not say that traditional farming and organic farming are intelligible only from the viewpoint of a distinctly different scientific protocol than that on which 'green revolution' farming is based. This alternative scientific protocol is not described.

In attempting to avoid contradicting themselves, textbook authors are passing on to children their own confusion and irresolution. Their confusion and irresolution are, of course, shared by everyone. It pervades all areas of practice and policy in contemporary global culture and simply cannot be removed except by the adoption of an alternative worldview and its derivative cultural model.

The positive aspect of this story is that the textbook writers are willing to reassess traditional Indian agriculture and, by implication, the worldview of which it is an expression. They are tacitly acknowledging the possibility that an alternative scientific protocol will be necessary to resolve the environmental crisis. But in doing so they are creating still more confusion.

## *Non-solutions*

While the subject of pesticide use was chosen to illustrate the problems of contradiction, incoherence and confusion being created today in the

school classroom by addressing environmental concerns using the infusion strategy, the subjects of chemical fertilisers, air pollution, resource depletion and nuclear energy production could equally have served. We turn to two of these now because they also illustrate how textbook writers resort at times to what we term 'non-solutions' and wild optimism. Again planners and textbook writers are not to be blamed; they only do what any of us would do in their situation. Moreover, everyone who is committed to the industrial development model is complicit in what is done by them.

In discussing the problem of resource depletion it is explained in the 8th grade science textbook (page 221) that non-renewable resources will eventually be exhausted. One solution is to find substitutes, but in the case of minerals, 'We do not have suitable substitutes for metals because they have certain unique properties. We can meet future demands of certain metals like manganese, copper and nickel by mining manganese nodules from the ocean bed.' This last statement is ambiguous but seems to imply a contradiction of the previous statement that all non-renewable resources will eventually be exhausted, and thus constitutes a non-solution.

In a discussion about nuclear reactors for electric power generation in the 10th grade science textbook (page 31), their advantages and potential hazards, the following passage occurs:

> ...However, a minor fault in the design of reactors or a natural calamity striking a perfectly designed reactor, could result in the release of this radiation into the environment, posing a permanent threat to those residing in it.... The world has already witnessed two major accidents in reactors...Three-mile Island and Chernobyl.... the devastation caused by these accidents is yet to be assessed correctly. Fortunately the design and operating procedures for Indian reactors make the possibility of such an accident very remote. The siting criteria and inbuilt safety features ensure that even if such an accident takes place, no significant damage is caused to the environment and the population in the vicinity.

This attempt to reassure the learner seems hardly likely to succeed. Further down the same page the authors avoid admitting that the problem

of safe disposal of nuclear wastes is well-nigh insoluble. They say 'Though environmentally safe practices are followed for disposal of nuclear wastes more accepted solutions are desirable for their disposal from a very long term point of view.'

It is part of the protocol of contemporary science that scientists have found the truth about the way the universe functions. Given this protocol, it follows that the technology arising out of this science is understood to be the only way to deal with livelihood, societal and personal issues. This understanding is never questioned. Even if this technology is found to be creating problems in practice, it does not occur to anyone that the underlying scientific 'truth' is, in fact, not the final word. Everyone readily concludes that further scientific developments following the same protocol will solve them. Or, in other words, fine-tuning is all that is required.

### *Who is responsible for our environmental problems?*

A selection of excerpts from the NCERT textbooks relevant to the question, who is responsible, is given in Appendix 2. Consider the first four sentences, and also sentences 6 and 7 of the first excerpt. They explain in brief the technical causes of soil erosion. In the same lessen students do simple experiments that demonstrate how wind and flowing water erode soils. However, a technical explanation of a problem is only half an explanation. The other half is who cuts down the trees and whose animals overgraze the land and why. This is a socio-economic problem. What does the text tell us about the socio-economic causation of the problem of soil erosion? Sentences 5 and 8 tell us that 'we' must not cut trees indiscriminately or allow animals to graze the same area continuously. Who are 'we'? Surely there are particular individuals, or groups of people, who do these things, and not all of us. And, more importantly, why do these individuals or groups do these things? Surely there are definite and compelling reasons. The near universal human emotions of greed and selfishness, of course operate, but the real cause is the dysfunctional political, economic, social and administrative structures designed to serve a model of 'development' that permit the

expression of these negative emotions and the destructive activities. And, more fundamentally, the cause is the worldview that legitimises that model.

Further, the use of the terms 'indiscriminate' is unacceptable. What does it mean? It implies that the cutting of some trees is all right, but not too many. Where is the dividing line between 'some' and 'too many', and what are the principles by which this line can be decided in practice? Also, should forests be 'protected', or are forests to be used judiciously to satisfy human needs on a continuous, long-term basis? As a result of this exposure, can we expect the rural child, when he or she grows up, to solve the problem of soil erosion on his or her own family's cultivated land, or in community-owned village forest land?

The same themes are repeated in the other excerpts in Appendix 2. In the second excerpt children are told that scientists have discovered that someone is overusing or misusing chemical fertilisers. Who is it that is doing this, and what is 'overuse' and 'misuse'? Is it farmers, or the scientists and extension agents that convinced him or her to use them in the first place? During the early years of the green revolution (1960s and 1970s) neither scientists nor farmers were aware of any negative 'side-effects' of fertiliser use. Or should we blame the fertiliser industry, or the governments which subsidise fertilisers? Maybe everyone is to blame because all subscribe to the scientific protocol underlying the science of modern agriculture. How can we, including children, hope to understand this problem if we do not understand its causation? And who will solve the problem? How can the individual child, or the community of which he or she is a part, contribute to a solution?

The fourth excerpt is a sweeping indictment of 'people' for 'overusing' resources and being 'wasteful'. Without defining any of these terms, this statement is meaningless, and for the learner probably only one more statement he or she must memorise. The child from an affluent family will not understand in what ways he or she is being wasteful, and children from poor households scarcely have an opportunity to be wasteful.

## *Who will solve these problems?*

The excerpts in Appendix 3 deal with the question of who will solve our environmental problems. In the case of factory pollution, the causation of the problems is localised and fairly clear cut. The factory managements will have to solve the problem, and there are techniques for doing so. There are even examples where problems have been solved, such as the case of emissions from the government-owned Mathura oil refinery where the health of the Taj Mahal was involved. The problem with less high-profile government-owned factories and the more numerous factories owned by private companies is more complex. Cleaning up emissions is costly. Who is to pay and why? How are factory managements to be forced to pay? Should they be forced to pay? Or should consumers pay? By and large our environmental 'greening' agenda has no guidelines for answering these questions. Why not?

The student is given to understand that the cleaning up of the Ganga is a straightforward matter. But the fact remains that the Ganga, several decades after the clean-up project was initiated, has not been cleaned up at all (2012). This suggests that the problem has not, in fact, been understood. As with all environmental problems, our society as a whole has failed to define this problem in systemic terms. Why do we need all the chemicals that are now being produced and which are hazardous to human, animal and plant life? What are the alternatives to producing and using them? Why should we use fossil fuels at all? Why do we think that the only way to dispose of human wastes is to flush them away with water? Is our entire development protocol the problem? If so, who will solve it?

## *A look at later editions*

In the later editions of the science textbooks (NCERT, 2006-2008) we find that the treatment of environmental problems is more sophisticated than earlier. The social dimensions of these problems are described in some detail, indicating that the textbook writers are beginning to articulate an authentic Indian environmentalism. The technical aspects are described

in more detail, including the drawbacks of various techniques. But the earlier contradictions, incoherence and general confusion remain.

In Chapter 15, entitled 'Improvement in Food Resources' in the 9th grade science textbook, for example, we find (p. 203):

> Scientific management practices should be undertaken to obtain high yields from farms. For sustained livelihood, one should undertake mixed farming, intercropping and integrated farming practices, for example, combine agriculture with livestock, poultry, fisheries, bee-keeping.

This statement is self-contradictory: mixed farming (mixed cropping was probably intended), inter-cropping and integrated farming practices are not modern, or green revolution scientific practices. They are features of traditional Indian farming and of ecological or natural farming which derive from entirely different scientific protocols, and these in turn derive from two distinctly different worldviews.

Later on in the same chapter the section on 'Fertilisers' (pp.206-7) is blatantly contradictory:

> Fertilisers are commercially produced plant nutrients. Fertilisers supply nitrogen, phosphorus and potassium. They are used to ensure good vegetative growth (leaves, branches and flowers), giving rise to healthy plants. Fertilisers are a factor in higher yields of high-cost farming.
>
> Fertilisers should be applied carefully in terms of proper dose, time, and observing pre- and post-application precautions for their complete utilisation. For example, sometimes fertilisers get washed away due to excessive irrigation and are not fully absorbed by the plants. This excess fertiliser then leads to water pollution.
>
> Also, as we have seen in the previous chapter, continuous use of fertilisers in an area can destroy soil fertility because the organic matter in the soil is not replenished and micro-organisms in the soil are harmed by the fertilisers used. Short-term benefits of using fertilisers and long-term benefits of using manure for maintaining soil fertility have to be considered while aiming for optimum yields in crop production.

In respect of nuclear power generation, the textbook writers are somewhat less equivocal, but, nevertheless, still hedge in drawing their conclusions. In the grade 10 Science textbook, chapter on 'Sources of Energy' we read:

> The major hazard of nuclear power generation is the storage and disposal of spent fuels... Improper nuclear waste storage and disposal result in environmental contamination. Further, there is a risk of accidental leakage of nuclear radiation. The high cost of installation of a nuclear power plant, high risk of environmental contamination and limited ability of uranium makes *large-scale* use of nuclear energy prohibitive (my italics).

The authors review various alternative energy sources, concluding that all have unacceptable environmental risks or are limited. And yet at the same time they affirm we will need more energy in the future. The contradiction here is left un-resolved. Children, like the rest of us are left feeling anxious and disempowered by this recital.

The textbook writers do not critically question why we need more energy, or even why we need to consume energy at the present levels. Of course almost no one does. Maybe it is time that we did. Could we not make a beginning in the school classroom?

## *Teach and test*

The school classroom scene today from the point of view of how children are learning presents a picture that includes:

- teachers dictating questions and answers to students who write them out in their notebooks;
- students copying such notes from other students;
- students, in response to the questions listed at the ends of chapters in textbooks, writing answers on the basis of the chapter text;
- students memorising solved question papers of previous board or entrance examinations;

- students guessing which questions are likely to be asked this year;
- students 'burning the midnight oil' before examinations to memorise answers to likely questions;
- an examination format that tests only students ability to memorise approved facts and definitions;
- board examination and entrance tests examination results a once-and-for-all assessment of the students' worth/ potential;
- a fast approaching situation where many students get perfect scores and there remains no basis for preferring one over another;
- teachers who understand that their job is to teach;
- outside the classroom a vast coaching and tutoring industry and a vast industry publishing study guides to reinforce what is done in the classroom;
- a vast bureaucracy to train and support teachers in their job of teaching.

All these are the outward expression of the 'empty receptacle' concept that shapes and justifies our present education protocol. 'Students' are empty receptacles and 'teaching' is the process by which they are filled by a person called a 'teacher'. In his or her work the teacher is guided to the last detail by an approved curriculum and approved textbooks.

This description is stark, possibly simplistic, but it is my intention to capture and draw attention to the essential nature of the problem we face. When this problem is understood in these terms, it will be evident that the new NCERT textbook formats and the new system of student evaluation (Comprehensive and Continuous Evaluation) (CBSE, 2010) are *in principle* inadequate as they do not really address the problem of a defective educational protocol.

In the new protocol presented in this book there are no teachers, no teaching, no students, no textbooks and no workbooks.

One aspect of our present educational system that the above list does not bring out is that it is competitive. Students are forced to compete with one another. Competition is a hallowed feature of our contemporary cultural model and is present in every sphere of human activity. It derives its rationale from the basic concept of a person as an essentially separate unit of society, dependent solely on his or her own effort to survive and prosper. Not everyone can survive and prosper, only the fittest. In the field of education the use of the word 'curriculum' betrays our assumption that life is a contest in which only the most able win; the losers drop out of sight (Box 1.1). The criterion of judgement is the ability of children to memorise the concepts and information adults deem important. With the living systems worldview attention

**Box 1.1**

**The derivation of the word 'curriculum'**

*The word curriculum is a thoroughly unsatisfactory word to designate the educational programme developed in this project. It is a Latin word which meant a course over which chariot races were conducted. It thus connotes a fixed pathway along which a race is to be run. This pathway is clearly and narrowly defined by walls on both sides to force the chariots to follow the course laid down. There is a fixed starting point and a finish line. The participants are competitors, vying with one another to cover the course ahead of the others and reach the finish line first. It is a rough sport and there are accidents in which the competitors are injured and sometime killed. There is an accident squad to clear the track after an accident so that the remaining participants are not impeded on the next lap. A handsome prize is awarded to the winner and much public acclaim is received.*

*There could not be a better description of what present-day school education has become. In this book I will use the term 'educational programme' instead of 'curriculum'.*

shifts from survival of the individual to the survival of the entire society of which he or she is an integral part; only if the society as a whole is healthy will each individual have a chance to survive. In the new educational protocol there are no curricula.

## *Prema's verdict*

Children themselves are aware of the meaninglessness of what they are expected to learn at school and the futility of how they are expected to learn it. Vanya Vaidehi Bhargava, writing in the *Hindu* (25/4/12) recalls that 'The Central Board of Secondary Education (CBSE) wanted me to know everything in my textbook as anything could be asked in the exam. But even as a teenager, a part of me was aware that I was being rewarded for mastering a technique - the technique of cramming.' She goes on to say '... home was where one mastered this art. School was definitely a place to fool around with friends and perhaps poke fun at teachers. Most of the teachers seemed to lack passion for the subject they taught.' Still, she decided 'Good marks in exams mattered. If cramming got me the marks, so be it.' Vanya was a 'good' student, gaining admission to St. Stephens College of the University of Delhi. Probably many students acquiesce in the 'system' as Vanya did.

> *By education most have been mislead:*
> *So they believe, because they were so bred.*
> *The priest continues what the nurse began.*
> *And thus the child imposes on the man.*
>
> - John Dryden, The Hind and the Panther
> (Quoted by Goerner, 1999, p. 95)

More often, criticism is indirect. Children may simply say 'I do not want to go to school. I don't see any point in it.' I do not think that these are all 'problem' children. When this is seen in adolescents, it may well mean that they have not yet been able to define themselves as individuals. They have not discovered their real interest or passion in

**Box 1.2**

## Prema's verdict

The Uttarakhand Environmental Education Centre (UEEC), Almora organised a meeting of women from various village groups with the Education Secretary, Government of India on 7th June 2003. Education Department officials from the state capital were also present. Women teachers and supervisors of village pre-primary centres which are being run with the assistance of the UEEC also participated. The women voiced their concerns expecting that doing so might lead to some sensitivity by government towards women's needs and interests. Some women were polite while others were rather curt and blatant.

During the meeting, a state government officer said to a teenage girl, *'You are very clear about what you want to do...what are your educational qualifications?'* Prema, blushing, said, *'High school.'* The officer remarked, *'Why don't you study more...don't you want to go to college?'* Recovering from the initial shock of this intrusion into her life in a public meeting, Prema had by now composed herself. So, she got up and replied, *'No, I don't want to go to school anymore because schooling can't give me what I want from life. I want to work with my own people in villages and when I work, I learn a lot. What do we do in schools... we just sit there... sometimes the teachers come to the classroom, often they don't... we memorise answers of some "important" questions and pass our exams...'* She paused and then continued, *'When I began working in villages, I realised that I had learnt nothing in school... I can read and write which is useful in its own way but all that information and knowledge I stored in my mind during school days is of no use. So, I am happy here.'* She was smiling now.

*'Certainly, no school will teach her to talk the way she is talking now,'* Nandi Devi of Rungadi village, district Pithoragarh, said. *'I have never been to school but I can talk, am fearless and the whole village listens to me.'*

*'Had this meeting been in some government office, and not here, people might have asked us to shut up by now,'* said Bachuli Devi of Pauri Garhwal. The Education Secretary asked her why she said this, and her spontaneous reply was *'They don't listen to us... our views just don't match theirs.' 'But I am listening to you,'* the Secretary said. And Anandi of Shama village, district Bageshwar, responded, *'Will you incorporate these perspectives in your educational policies?'* A frank discussion followed. (Adapted from UEEC, 2005.)

life, but they know it is not in pursuing the mainstream life trajectory that school education is preparing them for. They are not usually encouraged and helped to discover their own interests and articulate a possible life trajectory of their own. In the end most of them are bullied into acquiesence and spend long dreary years cramming. They do not make the top 10 percent and so are confirmed in their view that their years in school were wasted time. Those in the top 10 percent, meanwhile, go on to perpetuate the system about which they had doubts earlier.

Only a few young people, in my experience, are able to express their dissatisfaction as an effective critique of the school system from the point of view of what they see as being important to them. One of these is Prema (Box 1.2). In her outspokenness she had the support of her village community.

Sometimes children express their dissatisfaction with the present classroom routine indirectly in responding enthusiastically to innovations that depart from the routine. For 15 years, from 1987 to 2002 the UEEC developed and tested a course of environmental education in government schools with the collaboration of the State Department of Education. This three-year course (grades 6 to 8) is locale-specific, focusing on rural life and livelihoods. The organising theme of the course is the concept of the village as an ecosystem. In respect of pedagogy, it features small-group investigative work and whole class discussion, the teacher acting as a facilitator. There are no textbooks, only workbooks.[2] In observing various activities we (members of the UEEC team) were constantly struck by the enthusiasm of students. 'This is the only course that relates to our lives' we heard again and again. Learners who had completed the course asked why it was not offered in grades 9 and 10.

2. For details of the course see Pande, 2001, and Jackson, 2003. The workbooks may be seen at UEEC.org.in

# 2 The Living Systems Worldview

The new educational protocol that is being described in this book has for its rationale an alternative worldview to that which informs and justifies our present system of school education. It is therefore necessary at the outset to describe this alternative worldview. Two key concepts in this alternative are the living system and learning by reflecting on experience. These will be described in this and the next chapter. Other supporting concepts – those that are necessary to ensure that the worldview is self-consistent and coherent – will also be described briefly.

## *Everything is living*

It is obvious to perceptive parents and teachers that young children look upon all the things in their surroundings as living, even those things that contemporary science and society insist are inanimate. Stephan Harding, in his book *Animate Earth*, writes that psychologists studying child development recognise that children pass through an animistic phase in their early years, during which they relate to objects in their surroundings as if they are alive and have definite characters. They see this as a passing phase, appropriate only to children; they must be helped to outgrow this attitude and accept the world is composed essentially of dead, insentient matter.

> However,...James Hillman, a close student of Jung and the founder of Archetypal Psychology, suggests that animism is not, as is often believed, a projection of human feelings onto inanimate matter; but that the things of the world project upon us their own 'ideas and demands'...through our interaction with... [them], as long as we are free from an overly objectifying attitude. Hillman pointed out the danger of identifying interiority with only human subjective experience; a gaping construction site, for example, or a clear-cut mountainside, may communicate the genuine, objective suffering of the Earth, and one's sensing of this is not merely a dream-like symbol of some interior process which relates only to one's own private inner self. (Harding, 2006, p. 21)

There is also documented evidence that this intuitive assumption that all things are living persists into adulthood, even if not expressed. Many students of the Oxford Brookes University were found to agree with the idea put forth by the creator of the Gaia theory that the planet Earth is a living system. The following account of this is taken from Jackson, 2008, p. 21.

> The University offers a course on Gaia, MO 2676.2., *Gaia: The Earth as a Living System* (Haigh, 2001). In this course Professor Haigh uses student journals to foster reflective learning. The journals vividly portray students' reactions to 'the unorthodox ideas and contradictions of Gaia, [and also how they meet the challenge... of thinking] deeply, critically and self-consciously about their prior understanding of the world (Haigh, 2001).' A self-contained, two-week study unit entitled *'The Living Earth: an Introduction to Gaia and Geophysiology* concludes the course. In it students are specifically asked to say whether or not they think the self-organising earth system is alive. The more conventionally scientifically-minded students (that is, from the physical geography and environmental science streams) tend to say 'no', that at most, it is 'nothing but' a large, complex self-regulating system. Social science students, many of whom are active environmentalists, are, on the other hand, more open to considering the possibility that the earth

is a living being. The following comments, taken by Haigh from the students' journals, are of students in the latter group.

- Imagining the world as one big living system seemed a bit strange at first, but the more you think about it the more you wonder 'why hasn't anyone thought of that before'.
- Having never come across the concept before, I was very surprised at how easy I found the idea to swallow…
- 1st impression – what a pile of tree-hugging, hippy crap…
- It was interesting for me to see how conditioned my mind was to 'conventional science'.
- I've always seen the planet from a 'whole organism' point of view and I think most ordinary people do – it's only the scientists who have dismantled it into components for their own research.

This report suggests that the intuitive thought or feeling that all things are alive is not eliminated by the socialisation and educational programmes that children are subjected to, but only, as it were, pushed into the background. It can be called forth later in life under certain circumstances. In the case of these students the 'circumstances' seem to be the students' unease about the environmental and other global problems facing us, their acceptance of the fact that all efforts now being made to remedy these problems are ineffective, and their frustration over their own inability to think of any effective solutions to these problems. Of these, the latter two are, I think, crucial. Almost everyone is uneasy, but few are willing to admit that present efforts are ineffective – because of the implicit challenge such admission carries to their worldview. Of those few who are ready to accept that present efforts are failing, most conclude that nothing effective can be done – either by they themselves or by anyone else – and consequently are overcome with a sense of hopelessness. If, however, an altogether different way of thinking about contemporary problems is articulated by someone else that resonates with a deep intuitive idea or feeling in their own selves then it is immediately grasped. And, of course, there is the rare individual

who articulates a new way of thinking that draws out such a positive response in others. In this case, James Lovelock seems to have been such an individual.

In ancient European cultures the concept that the Earth and all things are living beings was mainstream. This is evident from the myths of these cultures, such as the myth of Gaia. From early times, however, it has been under attack, first by the Greek rationalists of the 4th century BC, followed by the Christian church in the Middle ages and finally, by the Enlightenment thinkers of the 17th century who decisively, or so it seemed, banished this concept in favour of the concept of a dead, mechanical universe. Stephan Harding has briefly reviewed this gradual eclipse of this concept (Harding, 2006, pp. 25-9). In the 17th century this concept was replaced by the concept that that all things are essentially machines as a result of the work of, for the most part, Descartes, Galileo and Newton.

In non-European cultures too the same concept is found. In Vedic culture, for example, all things are living beings, that is, organisms (see review by Jackson, 2013, Chapter 7). Further, the concept that all things are living beings never completely disappeared in Western culture after the 17th century. It is apparent in the Romantic movement of the late 18th century and the 19th century (Blake and Goethe, for example) and in the scientific establishment in the work of the vitalists and the organismic biologists (see review by Capra, 1997, pp. 20-28).

All these observations and reflections have led me to postulate the existence of universal human intuitions, of which the livingness of all things is one (Jackson, 2013 a, Chapter 8). This would account for the persistence of the concept throughout all human history – and its reappearance today in our time of crisis. It offers us a new, and yet old, point of view from which to address perennial human problems of how to live in the world and with each other.

## *Systems of things*

A little observation and reflection makes it clear that all things have parts and are themselves parts of larger things. However minute a

thing is, when it is examined carefully, it is always found to be made up of still more minute things. However large a thing is, it is always discovered that it is part of a still larger thing. Of course, there are limits to how small and how large a thing we can detect. The results of research in sub-atomic physics, and in astrophysics, confirm these propositions with respect to physical things. We must conclude that there are no ultimate physical particles or an ultimate boundary to the physical universe. At least we can never be certain that there are. These generalisations are most readily understood in respect to physical things like planets in a solar system and organs in an animal or human body, but can also be visualised to some extent in respect of thought things like a worldview or an educational programme, emotional things like a family or a neurosis, or a feeling thing like a good meal or the flu.

Given these generalisation, we can 'look at' or 'see' a given thing from two points of view. One is to see it as composed of parts and the other is to see it as part of a larger thing. The former has been termed the 'reductionist' view, the latter the 'holistic' view. In the reductionist view a thing is analysed into its immediate component parts and these parts are enumerated and described. The properties of the thing are ascribed to the properties of its parts. This is the prevailing view in modern science and in everyday life in contemporary global culture. In the holistic view a thing is described and explained in terms of its place, with respect to the other parts, in the immediately larger thing of which it is a part. The larger thing is termed a system. Since all things are composed of parts, all are systems.

The study of systems, from the smallest to the largest, has revealed that they are dynamic entities. That is, the parts are in constant motion relative to one another, literally in the case of physical things, figuratively in the case of other types of things. These motions are more or less repetitive, so that the system as a whole can be described in terms of a definite spatial- temporal pattern. (In the case the system is of physical

things the spatial aspect is actual. However, with systems of other types of things it is figurative.)

The only adequate method of describing a physical system as a whole is geometrical. The mathematical, that is the algebraic, method of Newton, though very precise, can only describe the relative movements of two parts within a system, but not all the parts at once; in fact, it cannot describe the simultaneous movements of even three parts. Some present-day scientists attempting to describe systems using geometrical methods (topology). For a discussion of this topic see Capra, 2008. All this has great implications for science and society. If, using the equations of Newtonian mechanics in the development of a new technology, where a direct, exclusive cause and effect relationship between two parts of a physical system is assumed, and deploy that technology in the system to manipulate a part, such manipulation will almost inevitably distort the overall pattern of the system, and so disable the system. Similarly with social systems such as a village community, or a family, or a classroom of teacher and students, a focus on any particular relationship between individual members (parts) can and often does, distort the system and render it dysfunctional. The prevalence of dysfunctional natural and human systems today clearly argues for a preference for a systems or holistic way of looking at things.

There is considerable evidence that in ancient European cultures, and also in non-European cultures, both ancient and contemporary (which were not colonised by the modern West), the holistic view is the cultural norm. In European history there was a decisive shift in the 17th century to the reductionist view, and this view has been embraced by most post-colonial societies, including our own.

Here again, I suggest that the holistic view of things springs from a common, universal human intuition.

## *Living systems*

Combining the two concepts, the livingness of all things and the systems view of things, gives rise to the living systems concept, the

central pillar in the structure of the alternative worldview that to me, and numerous others is imperative today. Such an alternative worldview will give rise to an alternative cultural model that will demand new protocols in every field of human endeavour.[1] It is in this way that the new protocol for school education that is described in this book has come about.

At this point in the development of the livings systems concept, an attempt must be made to say what life is. It must be made clear at the outset that life cannot be defined in isolation from the things that it informs. The presence of life in things is known only by the characteristics it imparts to them. These are:

- ***Spontaneous activity :*** This activity takes the form of self-propelled movement in relation to other things in the system in which it participates.
- ***Sensitivity :*** Things are sensitive to the presence of other things in their surroundings, that is, to all the other parts of the system. They know exactly where every other part of the system is, in relation to themselves at every instant.
- ***Intelligence :*** They are able to translate the inherent knowledge of their places and functions in the patterns of the systems in which they participate into appropriate action.

It is easiest to visualise these attributes of living things in physical things, but they apply to thought, emotional and feeling things as well. In the case of a concept (a thought thing), for example, its 'movement' within a worldview (a large thought thing), its meaning is not rigidly fixed, but changes continually in relation to the other concepts in the system as the system interacts with new facts that come before it, though not fundamentally.

1. For a comprehensive account of my own version of such an alternative worldview see Jackson, 2013 a.

A thing knows its place and function in the system in which it participates because a common, cosmic causal agency works from within each thing. Every individual thing possesses knowledge of the totality of the patterns of all systems, from the smallest and simplest to the largest and most complex, past and present, and can access any of that knowledge whenever needed. This concept was known in Vedic culture as *Rta*, in Taoist thought as *Li*, and in European culture as *anima mundi* (soul of the world). A modern metaphor for this is the hologram in which a picture of the whole can be seen in each of its parts.

This concept was replaced in 17th century Europe by the concept of causation by the action of forces operating between pairs of radically discontinuous bits of insentient, material substance. This is the concept that is now failing us so spectacularly.

The concept of a common, cosmic, causal agency enables us to explain not only the observed behaviour of systems, but also account for the experience of subtly participating in our natural surroundings that is particularly evident in young children. In traditional human communities too, this subtle feeling of participation is also evident. In other words, human beings, it seems, like all things, are endowed with knowledge of the patterns of all things. This knowledge can be accessed, that is, understood, only through intuition. Cultivating a habit of openness to intuitions and developing the ability to articulate them logically need to be recognised as important objectives of education. How these objectives are to be met will be taken up in the next chapter.

To round off this section on living systems the defining general characteristics of all systems may be indicated. They are four in number.

- Systems are self-limiting. This means that they, as it were, draw a boundary line around themselves. This demarcates them from other systems.
- Systems are self-defining. As they come into being they spontaneously reveal the essential pattern or form that distinguishes them from all other types or species of things.

- Systems are self-organising. They assume their essential form independently of any external conditions.
- Systems are self-sustaining - if not subjected to undue disruptive external influences.

The fourth of these characteristics is the key to the sustainability of all the natural and human systems in which we find ourselves embedded. The concept of systems health may be deployed in considering any interventions we (human beings) contemplate making in any of these systems. The ready metaphor for this concept is a human body in sickness and health. Virtually all illnesses that the human body is liable to are a result of stresses we ourselves inflict on it. And the treatment for these diseases is to identify and remove, if possible, these stresses. Sick bodies and minds heal naturally if external stresses are removed. If we are circumspect, we will avoid making healthy systems sick by our interventions in them. All of this, of course, depends on our ability to discern the essential patterns of various types of systems and our resolve to act so as to maintain the essential integrity of these patterns.

There are two types of living systems, naturally-occurring and human-made. All the examples given so far have been of naturally-occurring systems. Human-made systems are social organisations (families, communities, companies, schools) and human made artefacts like human-modified natural systems (farms, dammed rivers, cities and domesticated plants and animals). And finally, there are machines. All these human-made and human-modified systems are embedded, ultimately in natural systems. Their functioning ultimately affects the functioning of these natural systems. Great circumspection is thus needed in creating and deploying human-made systems. Things like antibiotics, pesticides, plastics, cities and motor cars, for example, are destructive of natural systems because we have not seen them in relation to the natural systems in which we create or deploy them. Only the living systems worldview will enable us to do this – and thus avoid the planetary ill health that contemporary global culture is causing.

# 3 Learning by Reflecting on Experience

It is my intention in this chapter to suggest an alternative concept of learning. This concept derives it rationale from the living systems worldview. A person is a living system. This system is composed of four subsystems: physical, mental, emotional and feeling. The whole person evolves, and the way he or she evolves depends on what, and in what way, he or she learns. There is positive learning, in which a person attains a healthy maturity, and negative learning, the result of which is a sick or stunted person. A healthy person contributes to the creation and maintenance of a healthy society and the maintenance of healthy natural surroundings.

To grasp this concept of learning by reflecting on experience it will be necessary to ask and attempt to answer the following questions:

- What does it mean to experience something, or to come to know something?
- Who is it that experiences or comes to know?
- What is it, actually, that is experienced or known?
- What does the term 'reflection' mean?

In formulating answers to these questions it is imperative that we forego the ready-made answers that are sanctioned by our contemporary educational protocol and instead go back to square one, so to speak.

Experience, in its simplest, most elementary sense, is, I suggest, becoming aware of something, whether it be a physical object, a thought, an emotion or a feeling. In one experience only one thing appears. Moreover, an experience of a given thing is only momentary – literally lasting only a fraction of a second. Experiencing is actually a stream of momentary appearances of things. All these statements can be verified by close attention to one's own experiencing.

The same thing may appear repeatedly in a series of consecutive experiences – or at least the things in consecutive experiences are very similar. The Mahayana Buddhist philosophers of the first centuries AD insisted that the flame of a lighted *diya* is not one continuous flame, but a series of similar flames. Heraclitus, the Greek philosopher, half a millennium earlier used the example of a river: it is not, he said, a continuously existing entity, but a different river from moment to moment. 'You never enter the same river twice,' he said.

If things are not enduring entities, but only momentary experiences, like the individual frames in a motion picture film, then we are faced with the crucial question: what is the real nature of the things we experience? Do they have an independent existence, independent, that is, of me who experiences them? This question has been the subject of sporadic debate down the centuries. The mainstream consensus in all cultures has, however, been that there is a world 'out there' which I, 'in here', cognise. If my cognisance of it seems to be discontinuous, it is merely due to my flickering attention. This assumption is, however, facile since it glosses over the logical discontinuity in the process by which things 'out there' are cognised.[1] In the 18th century, the German

1. Light rays, it is said, reflected off an object in my surroundings, strike my eye, generating electrical impulses which travel via nerves to cells in the brain. These are converted to an image 'in here' of the object 'out there'. The process, up to the receipt of electrical impulses by brain cells, is physical, but in the brain cells these are converted into a non-physical visual image. How this transformation occurs is not explained. Moreover, there are the awkward questions of what thoughts, emotions and feelings are, and where they come from. Clearly, they are not 'out there'.

philosopher Immanuel Kant argued that we can never know that physical things continue to exist when we are not looking, and no one since has managed to refute this statement.

The upshot of all this is that we are forced to conclude, first, that experiences *per se* are the ultimate, irreducible facts with which we must deal, and, second, we must acknowledge that appearances of things in experiences is simultaneous with our cognition of these things.

'Reflection' means holding a particular experience in awareness and seeking its significance. An experience becomes significant when it is placed in some already-constructed context, that is, a group of similar experiences recalled from the past. Such a context enables us to describe an experience in terms of its similarity with those other previous experiences. We say the experience is similar in one or more particular ways to those earlier ones. Or, the context may be a concept, or system of concepts, that explains why the experience is the way it is. A more generalised statement is that a thing is understood when it is seen as a part of a system. In doing this, an experience gains meaning, and this learned meaning enables us to act in definite ways in the future. If we are unable to place an experience in a context, it will be ignored, if possible, but is likely to become unsettling, even threatening. When we have satisfactorily related an experience to a definite context, we say we have 'understood' it.

When we see a thing in a context, the seeing is itself an experience. It is an experience of a thought thing. The first context in which we place a thing is invariably the human body that I identify as 'me'. Thus, 'I saw (felt or heard or touched or tasted or smelled) this thing', or 'I thought this thought', or 'I felt afraid', or 'My left ankle hurts'. This primary contextualisation is not usually sufficient for adequate understanding and is followed by secondary contextualisation experiences such as 'I see this book in a bookcase', or 'the sun is rising in the East', or 'that girl is Prakash's sister', 'this chemical element fits here in the periodic table of elements', or 'this disease is a cancer', 'this concept is part of such-and-such worldview'. In contextualising a thing we typically

progress through a hierarchy of increasingly larger and more complex contexts before we feel satisfied that we have understood it. The ultimate context of the totality of our experiences of all types of things is 'the world'. Each of us constructs a world from his or her experience. Fortunately, these worlds are sufficiently similar to enable us to co-ordinate our activities reasonably well.

Contexts are handed down to us as part of our cultural heritage. Every culture perpetuates itself by preserving and passing on the contexts that have been created in the past and tested over time. Children learn accepted ways of thinking and doing from parents, teachers, and role models. This type of learning may be termed 'passive learning'. The learner simply takes on board a set of already-constructed contexts. In conventional, formal learning programmes lessons are designed to pass these on as efficiently as possible.

There is another type of learning which may be termed 'active learning'. In this case the learner finds himself or herself with no ready-made contexts, or he or she rejects those that are offered by his or her society because they seem inadequate. He or she must then construct his or her own contexts. This constitutes a tremendous challenge; with no ready-made contexts the learner feels confused, insecure, frightened; he or she can either retreat by accepting, even if unwillingly, the contexts offered by his or her society, or resolutely attempt to construct his or her own contexts from scratch. It is hard work, and success is by no means certain. The term 'success' here means that the newly-constructed context is recognised as useful – more useful than existent contexts – by others as well as by the person who constructs it; it may then enter into the cultural mainstream.

The foregoing description of active learning is too general as it stands to be useful in our work. Stephan Sterling has suggested, in effect, that there are three distinct types of learning. The first of these is the passive learning described above. He terms this 'first-order' learning.

In second-order learning the learner finds existing contexts inadequate in terms of creating understanding. He or she rejects these and then

constructs a new context to meet his or her need by elaborating and rearranging existing concepts.[2] In doing this he or she does not reject the basic concepts of the worldview of his or her culture. Better types of formal educational practice seek to develop the learner's ability to undertake such second-order learning.

Sterling's third-order learning requires the learner to reject the basic concepts of the worldview of his or her cultural era and constructing entirely new ones. This becomes necessary because no amount of elaboration, re-interpretation or reformulation of existing contexts is adequate to make sense of a novel experience. A new basic concept, like the livingness of things, or the inter-connectedness of all things, must be created. Third-order learning is thus transformative learning; it is the process by which an entirely new worldview is created, in terms of which our entire outlook is transformed.[3]

In the new educational protocol being described in this book, first-order learning is kept to a minimum. Instead children are asked to undertake activities that will generate a specific set of experiences. They are then asked to 'make sense' of these experiences by formulating suitable contexts (second-order learning). The contexts they come up with may not be adequate, and so they are further required to evaluate them critically. This is facilitated by probing questions from the facilitator and through small-group learning where each group is required to come up with a single, agreed context.

In everyday life and science there are numerous sets of experiences for which no adequate contexts based on the worldview of contemporary

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2. Arthur Koestler in his book *The Act of Creation* (Arkana, London, 1964) has pointed out that a common way, not generally recognised, in which new contexts are created is by bringing into view inter-connections between existing concepts that were not seen earlier.

3. Sterling, S. (2001). *Sustainable Education: Revisioning Learning and Change*, Foxhole, Dartington, Totnes, Devon, UK: Green Books Ltd. Sterling's account of second- and third-order learning is very sketchy. They have been elaborated for use here.

global culture are possible. An example of such a set in the field of agriculture is given in Appendix 4 (Learner Handout 3.2, *Pests*). Students are confronted with such a set and asked to find a viable context, or, in other words, find a solution to a contemporary problem – a solution that does not create yet more problems. These are third-order learning challenges. Some adults may have solved problems such as that narrated in the story '*Pests*' in Appendix 4, but in order to do so they themselves have had to undergo a process of third-order learning which involved abandoning current assumptions and formulating new ones. Because they have done so, we know that an answer is possible. An example of a successful solution is seen in the story of Masanobu Fukuoka's formulating his concept of Natural Farming (Fukuoka, 1992). But, simply telling a child, or anyone else, about a solution may not be sufficient to engender conviction and consistent thinking and action in the future; he or she must go through the struggle of finding a solution for himself or herself. It is the struggle that is important. An unsuccessful struggle often has the result that a person becomes open to a solution from another, whereas without the struggle the suggested solution would have been dismissed as impractical or foolish. Similarly, struggle often has the effect of opening a person to intuitions that were earlier unavailable or ignored, but which help in finding solutions to such problems. This too is a feature of the story in Learner Handout 3.2 in Appendix 4. The teacher in this new educational protocol must pose a problem and allow the students to struggle. If they are unsuccessful, he or she may suggest a solution, tentatively, which may be enough to enable students to complete the third-order learning exercise successfully.

Not surprisingly, children have less trouble with third-order learning challenges than adults because the worldview of contemporary global culture has not yet been fully absorbed by them. If they are allowed to follow their own intuitions – or, indeed, encouraged to do so – third-order learning becomes an exciting challenge for them. For example, if children are allowed to bring to bear on the problems of unsustainable agriculture their intuitions of the livingness and inter-connectedness

of all things, finding a solution is not nearly as difficult for them as it is for adults who have been educated into denying these universal human intuitions. For this reason, the first task in initiating any educational programme based on the new protocol is to provide teachers with an opportunity to undergo a personal transformative learning exercise.[4]

One question remains: Who is it that experiences or comes to know? We say, 'I have learned', just as we say 'I have seen'. What do we mean? The first step in formulating an answer has already been taken a few paragraphs back where it was said that the person, that is, a living system, is the primary context to which all experiences are referred. A new-born baby, so it appears, has no such context in which to place the things it experiences. It slowly builds up a personal context by exploring its body. This context gains clarity of detail as the child grows. A point is reached at which the experience 'there is hunger' becomes 'I am hungry'. The person has arrived. It is this person who learns.

4. For a detailed consideration of this topic see Jackson, 2008, Chapter11.

# 4 The New Educational Protocol

In this chapter I will describe the new educational protocol. Following this protocol it will be possible to construct an educational programme for children 6 to 16 years of age in any region of the country and socio-economic setting. The protocol is designed to ensure that all children are given an opportunity to learn what is necessary for them to become responsible and effective participants in national life. It will also ensure that what they learn is relevant to their own lives. Finally, it will ensure that all children develop learning skills that will enable them to deal effectively with the multitude of problems that our society faces today.

The protocol will be described under two broad headings: 'structural features' and 'procedural features'.

## *Structural features*

### *1. Activities*

In programmes based on this protocol learning occurs in discrete units termed, simply, activities. By means of these children interact with one another, with a learning facilitator, and with the natural and human systems in which they find themselves. New knowledge, concepts and skills are learned by children, the learning facilitator and community members. Activities are planned in advance by

the learning facilitator in terms of their structure, but not in terms of any specific learning outcome.

### *2. Knowledge, concept and skill maps*

Activities must be arranged one after another in accordance with the complexity of the knowledge to be acquired and the concepts and skills to be developed. In other words, every activity will have one or more pre-requisite activities, that is, activities that must be completed before the given activity is taken up if effective learning is to be possible. The knowledge acquired and the concepts and skills developed in the pre-requisite activities are pre-supposed in taking up the given activity. Experienced programme planners recognise this, but even then many mistakes can be made. To reduce the chances of such mistakes, knowledge, concept and skill 'maps' should be constructed. These show at a glance the correct position of any activity in relation to all other. A sample concept map is given in Appendix 6.

The idea of mapping knowledge, concept and skill chains or webs has been suggested by Roseman and Stern (2003).

### *3. Annual calendars*

Some activities are season-dependent, such as those involving crops, spring flow and air-pollution, and they must be scheduled in those seasons. Because of this, annual activity calendars need to be prepared in advance which show in which month each activity is to be undertaken. Activity calendars thus break the programme into annual units.

The need for annual calendars and for arranging activities according to 'maps' results in a graded series of annual activity units, what in present-day terminology is called 'classes' or 'grades'.

### *4. Batches*

Given the limited resources available to schools, children will necessarily have to move through the programme, grade by grade in batches. The most convenient basis on which to form these batches is the age of the child, though age need not be the sole criterion for assigning individual

children to batches. Thus while an individual student will not be able to move through the programme at his or her own pace, there are compensations. Group learning is more effective than individual learning, and the programme is designed to exploit this advantage fully. Further, this advantage is realised equally by fast and slow learners, as will be made clear in the following section on procedural features. Finally, individual students need not participate in all the same activities; each will have a choice, within limits, of the activities he or she joins. This too will be explained in the next section.

### 5. Daily timetable

Another structural feature that is necessary for operating a programme is the setting up of a daily timetable. Activities should, as far as possible, be designed so that they can be completed in one session. The length of a session depends partly on children's attention span and partly on the nature of the activity and can vary from half an hour to a full day. The shorter sessions are for young children and the longer ones for activities that are carried out outside the classroom and outside the school campus. The standard length of a session or activity period might, for example, be 40 minutes, with a provision being made to run several periods together to give longer periods when needed. This will not be uniform for all batches. Thus great flexibility will be needed to accommodate the varying time requirements of different activities. A weekly meeting of the school administrator and facilitators is suggested to construct a timetable for each batch for the coming week.

### 6. Near-to-far-rule

As a general rule activities should focus on the learners' local context, in the first instance, and only gradually move on to those activities which have larger and larger contexts. Thus, for example, a rural child will begin by learning about his or her local ecosystem, then regional, national and global ecosystems; local, regional, national and international history; and so on. In this way, the child is continually able to relate to what he or she is learning, however remote or abstract in relation of his or her immediately lived experience.

### Summary

These are the only structural features of an educational programme based on this protocol. There are no others. There are no subjects, no distinction between 'curricular' and 'extra-curricular' activities, no distinction between 'theory' and 'practical' topics, none of the structural features that characterise contemporary programmes.

The first, and crucial, step in constructing a programme in accordance with the new protocol is to decide on the activities that will comprise it. This can only be done on the spot by those people who will conduct the programme. Their judgement must be final. Of course, they will make mistakes, but when they do they will learn from them and thus continually improve the programme. And, of course, they can learn from the experience of other groups, and share their own experience with other groups.

## *Procedural features*

The procedural features of the protocol are described in this section. Except perhaps for number 7, none of them is new but derive from the experience of innovative teachers and programmes already running. Unless otherwise stated, these features are those of the UEEC course *Our Land Our Life* (www.ueec.org.in).

### *1. Conducting an activity*

No fixed format is prescribed for this transaction. The learning facilitator is free to innovate and to vary the structure of individual activities as may be appropriate. It is, however, expected that he or she will avoid lecturing as far as possible; the learning transaction is not one of information transfer. Instead, questioning, classroom discussion and small-group work are to be employed. In general, a final whole batch discussion should be held at the end of each activity to ensure that the concept which the activity has been designed to develop has been understood by all the learners. Finally, learners are expected to demonstrate that they have acquired the skill(s) intended in the course of their work in carrying out the activity. A few sample activity guides are given in Annexure 4.

Information and concepts are not given, as far as possible, but generated by learners themselves through the activities they undertake. Activities involve the collection of qualitative and quantitative information about selected phenomena, processing this information in appropriate ways, drawing conclusions from it, seeking to understand why the given phenomenon is the way it is and finally describing their findings in clear and correct language, written and spoken or in precise, accurate mathematical symbolism and geometrical diagram.

Each learning facilitator will be assisted by an apprentice. This will be necessary where student batches are more than 15 or so to ensure adequate support to learners when they undertake group work and when the group goes off campus to conduct activities. Further, there is considerable work of record keeping (see item 3 below). Apprentice learning facilitators will have gone through the new programme themselves. The apprenticeship period can be of two or three years, after which they will be eligible to become learning facilitators themselves. Their appointment as apprentices will be done by the local groups, as also their certification on completing the apprenticeship programme and their appointment as learning facilitators.

This concept of apprentices is, as far as I know, new to this protocol.

### 2. Use of stories

Real-life, present-day and historical stories, as well as fictional ones, should be used extensively. These are presented in Learners' Handouts included in Activity Guides. Facilitators are encouraged to create their own stories for use in specific activities. An example of a story (*The stone axe*) is given in Appendix 4 (Learner Handout 2.1).

### 3. Learners' files

There are no textbooks or workbooks in this programme. Learners will do their work on plain white sheets of paper called 'worksheets'. Blank worksheets will be handed out at the beginning of each activity. Each worksheet will have printed spaces for the learner's name, grade, number and title of the activity, and the date. They will be collected at

the end of each period by the learning facilitator. (When an activity is not completed in one period, the collected pages will be given back to the children at the beginning of the next period.) Each child's completed work will be collected by the facilitator and filed in a separate file for each child. They will immediately be evaluated by the facilitator and he or she will also write notes of his or her observations of the child made while the activity was in progress. These files remain with the facilitator and are not returned to the children. At the end of the academic year the facilitator will summarise his or her observations over the year and turn over the files to the school office where they will be kept for the duration of the child's attendance in the school and at least five years after that. These files should be available to other teachers, school administrators, parents, and, later, potential employers.

The idea of dispensing with textbooks and workbooks alike in order to make learning less structured was suggested to me by David Selby of Sustainability Frontiers.

### *4. Learner Handouts*

Where required information and concepts cannot be generated by means of activities alone, or where songs and stories are to be used, they may be supplied in the form of Learner Handouts. Suggested handouts are given in Learning Resources Handbooks. They can be photocopied and distributed to learners. Older children may be directed to the library or internet for specific information that may be needed. This information may be copied or printed out by them and submitted with their completed activity sheets. The copies of the handouts should also be handed back along with the completed activity sheets.

### *5. Learning Resources Handbooks*

Learning facilitators will be provided with Learning Resources Handbooks to guide them in conducting activities. These will serve as reference books on the protocol for the new programme, its structure and the general method of implementing it, as well as detailed suggestions for conducting each activity in the form of activity guides. The Handbook

will be prepared by the local group running the programme, and can be revised in light of experience as often as necessary. The Handbooks will also introduce new facilitators to the new educational protocol.

### *6. Learners work in small groups*

Experience with school children of all ages is that they learn better working in small groups than alone. The Learning Resources Handbooks indicate where this is useful in conducting various activities.

The procedure for this is to divide a batch into groups of three to five learners each, trying to ensure that exceptionally fast learners and also slower ones are represented in each team. After a general discussion in which the objective of the activity is made clear to the children, the members of each team collect at one place in the classroom, or wherever the activity is being conducted, and then gets to work. A time limit is set. The entire batch then re-assembles and one child from each team briefly reports to the whole batch his or her team's findings and conclusions. These are then discussed, the discussion being monitored by the facilitator. An effort is made to reach a consensus, or if the activity was the quantification of a given phenomenon, the data sets of all the teams are tabulated and processed statistically. The presenter for each team is rotated from activity to activity.

In making up teams the facilitator should try to distribute the quicker learners and the slower learners over all teams. The former can help the latter, and ensure that every member of the team shares in what is learned, and contributes to its learning. The extra attention that the facilitator would need to give slow learners in an undivided batch is, in effect, given by the quicker learners. Taking on this extra responsibility, the fast learner is helped in his or her own self-development.

I took this idea from my wife Pramila who was using it, some 40 years ago, with her primary school classes. Small group learning was made a regular feature of the *Our Land Our Life* course.

### *7. Learners plan an activity as well as carry it out*

Where an activity is investigative in nature, teams are given the task of planning it as a preliminary to actually doing it. The plans of

various teams are presented to the whole class and discussed. One plan is agreed upon by all. This planning includes how data will be recorded systematically in an agreed format.

This feature is, as far as I know, new to this protocol. It was suggested to me by Dr. G. P. Pande of the UEEC (Pande, private communication, September 2011).

### *8. Learners' feedback on the programme is sought*

Senior learners are to be invited to give their comments and suggestions on the programme and suggestions for future improvements. This practice is followed in some universities, but is perhaps new to school-level education. It has been prompted by the perceptive comments of students when reflecting on their school experience (see section 'Prema's verdict' in Chapter 1).

### *9. The learning facilitator*

From everything that has been said in the foregoing sections it is obvious that teacher's role is that of a learning facilitator. He or she becomes another participant in the discussion, while at the same time, of course, maintaining order. When the class is clearly stymied by a problem, the facilitator can usually contribute a catalytic idea or a necessary piece of information that will get the discussion moving forward again. This function is often critical, because the tasks, questions and problems posed in the activity are purposely framed in ways that fully test the learners' ability to reason and sometimes force them into third-order learning. Where the objective of an activity is to force children into third-order learning, it is best to push them to the limit, that is, that point at which they are stymied and thus prepared to respond positively to the slightest nudge from the facilitator or to listen to any intuition they may have. Many activities are designed to force learners over a conceptual watershed into a new, initially unfamiliar territory. An example of this technique is given in Annexure 5 (Learner Handout 3.2).

In my experience with the UEEC course *Our Land Our Life*, many teachers with a conventional training and present-day teaching experience,

when requested to take up the running of this course, successfully make the transition from being 'teachers' to being 'learning facilitators', though it takes two or more years and multiple course orientation workshops. This is remarkable in view of the fact that the remaining portion of the school curriculum remains as it is. However, most teachers are not altogether successful in making this transition. This observation has led me to include the practice of apprentices and their training and certification outlined above.

### *10. The programme is flexible*

In formulating a programme of school education in accordance with this protocol the knowledge, concepts and skills that are thought necessary for every child to acquire during his or her 10 years of school education should be specified. Once a child has reached these levels, he or she should be given a choice in what they wish to learn further. Thus, at least in the last two years, they should be given the opportunity to select from among a number of elective modules (that is, groups of specialised activities). What elective modules a given school will offer will depend upon the availability of staff and facilities, and upon the numbers of children wanting to take particular modules. The subject matter of modules may be vocational, addressing livelihood opportunities, or more general like science, language, mathematics, history, art, economics, or business. Special interest projects may also be undertaken by individual children, if guidance can be provided. Even younger children might be allowed to pursue small projects of their interest; space in the daily timetable might be made for this. Some projects, like a vegetable or herb garden or collecting butterflies or rocks, can be undertaken by children at home in their out-of-school time. Again these should be guided by a learning facilitator.

To provide individual guidance to children, each one should be assigned to a learning facilitator as an advisor for the duration of his or her studies. The advisor monitors the child's progress, helps sort out problems and is, ideally, a person with whom the child can share. The advisor helps the child to identify his or her strengths and interests and decide

on what elective modules to take. The advisor will consult the learners' files in the school office in his or her advisory work.

Flexibility in the learning programme, and the provision of advisors, are routine features of university-level education. They are equally important at the school level.

### *11. The local community is involved in the programme*

The range of topics included in this programme is much greater than in present-day mainstream school curricula because of the variety of elective modules offered. Where the needed technical expertise is not available among the staff for conducting a particular activity or module, someone in the local community may be able and willing to conduct it.

More generally, many activities in the programme consist of investigating local practices, knowledge and attitudes, and local residents are requested to allow children to measure the yield of their crops, water consumption, and so forth. In some activities children are required to take the advice of their parents and neighbours before beginning. Other activities require children to share their results and observations with community members in meetings and school fairs. Schools are encouraged to organise school fairs once a year to display children's work. Parents and community members in particular are to be invited. The children of each team put up a stall with the help and guidance of their learning facilitators. For an example of such fairs, see the UEEC *Our Land, Our Life* course workbooks (www.ueec.org.in).

In all these ways parents and community members in general develop a sense of participation in, and responsibility for, the school's programme. They share the information, knowledge and insights that emerge from the activities. The activities are no longer only the children's but also the community's. Since learning facilitators gain new knowledge and insights in conducting activities, they are also beneficiaries of the process. Learning in this protocol is thus a three-way transaction among children, community members and learning facilitators.

## *12. Learner evaluation*

In this protocol there are no examinations, final or otherwise – for the reasons explained in Chapter 3. There are no failures: all learners reach the goal of 10 years of school education, and are thus enabled to function as responsible members of society. Every child is assumed to be a learner – if his or her interest is aroused.

Learning facilitators evaluate the student's response to the learning opportunity offered him or her and record it on the worksheets of the activities and in a summative way at the end of each year as explained in 3 above. The educational NGO Prajayatna under its Lalikayathna (learning initiative) programme in schools in Karnataka use the following evaluation categories:

1. 'Evolving'
2. 'Interested'
3. 'Involved'
4. 'Self-directed'

The great advantage of this scheme, to my mind, is that it is positive; even the lowest level of response is seen positively. Some such scheme, I suggest, should be developed by any school or group of schools undertaking to conduct a programme designed on this protocol.

Anyone wishing to decide on a student's suitability, after completing 10 years of school, for employment or admission to a higher educational programme should find this adequate. They can also be allowed to look at the learner's file in the school office, and talk to the learner's learning facilitators. As for specific skills and knowledge, most employers already see the need for initial on-the-job training, and higher educational institutions provide for remedial courses.

# 5 Constructing a New Programme

In this chapter I will offer a few general suggestions for the construction of a school programmes based on the protocol outlined in Chapter 4. These are: how to ensure that programmes are fully informed by the living systems worldview; how to construct knowledge, concept and skill maps; how to construct annual calendars; how to apply the near-to-far rule; and how to tailor programmes to local conditions and requirements.

## *Informing the programme with the living systems worldview*

Ensuring that programmes are fully informed by the living systems worldview is a formidable challenge because all of us have been educated in programmes informed by the dead-particles worldview. It is only by meeting this challenge successfully that, as was noted in Chapter 3, we will be able fully to overcome the habitual ways of thinking engendered by school education.

Activities for younger children should be planned with an eye to encouraging them to express their intuitive feelings for the things in their surroundings, particularly for the visible, tangible features like animals, stones, plants, mountains, the moon and so on. Children love to sing, dance and draw, and make things and they should be provided opportunities to

express themselves in these ways. They respond enthusiastically to stories and there is a wealth of existing stories in all cultures that can be used. In addition to stories about relationships with the things in their natural surroundings, there are also numerous stories that explore human relationships. These too are vitally important. Children can be encouraged to make up their own stories. Later on they must be encouraged to express themselves in writing as well. In general, activities should emphasise connections among things and their mutual dependencies rather than competition and violence.

The UEEC *balwadi* (pre-school) programme takes this approach (see www.ueec.org.in, Nanda, 2001). In this we have carried forward the initiative of Sarla Devi of the Lakshmi Ashram, Kausani, District Almora, Uttarakhand. In 2005 the UEEC *balwadi* model was adopted by the Uttarakhand Education Department for its *anganwadi* (preschool) programme in place of their existing programme, and the UEEC was requested to help with its implementation.

This approach should logically be extended to older children (6 to 11 years of age). Recently, the Delhi Municipal Corporation has begun an experiment with a similar model in 20 of its primary schools (as reported in the *Hindu* of 24/1/12). This programme, named 'art-integrated learning' has been formulated by the NCERT.

With older children a more explicit effort will be required. To begin with, I recommend a set of 12 activities which should be included in all programmes. This set of activities, given in Appendix 5, is intended to be used with children in the age range of 11 to 12 years (grades 6 and 7). It will be the foundation for the further study of all natural phenomena. Other groups of activities that can follow on from these 12 foundational activities are:

1. introductory study of plants, animals and micro-organisms
2. study of elements and compounds
3. the nutrition of plants, animals and micro-organisms
4. reproduction in plants, animals and micro-organisms

5. organisms and their habitats
6. weather and climate
7. people in the ecosystem
8. the solar system and beyond
9. climate change

Each of these activities will have to be approached from the standpoint of the conceptual framework laid down in the foundational activities. For example, the relative movements of the bodies in our solar system or of the elements in compounds are to be explained in terms of the behaviour of living beings, as parts of living systems, and not in terms of Newtonian mechanics. Geometrical descriptions will be used, not algebraic equations. The behaviour of plants, animals and micro-organisms in an ecosystem, and the organs in the human body, are to be described in a similar manner.

## *Constructing knowledge, concept and skill maps*

The importance of being able to construct knowledge, concept and skill maps in making a programme cannot be over-emphasised. Those who have created present-day school programmes are not sufficiently aware of this concept or of how much confusion results when programmes are constructed without their help.

A programme constructed according to the new protocol is a system of activities. Each activity is necessary; it has a unique place in the system and a unique function. If any particular activity is absent, or is wrongly placed in the system, the functioning of the system as a whole will be adversely affected, producing less than satisfactory learning outcomes.

An awareness of this requirement itself will alert those engaged in constructing a programme for the need constantly to visualise, as far as possible, the place and function in the system of each activity they create. By the word 'visualising' I mean constructing a two- or three-dimensional map or model of the system. To begin with, subsystems,

or groups of closely related activities, may be mapped. For example the relationships of the activities in the set of 12 activities in Appendix 5 to one another are shown in Appendix 6. When further sets of activities, for example, those dealing with natural systems listed above, are prepared, they may be integrated into the map in Appendix 6.

In practice, it is necessary always to ask oneself when creating a new activity: what knowledge, concepts and skills am I assuming the child already has; where (that is, in which activities) have they been acquired; if they have not been developed earlier, then what am I going to do about it? For example, does he or she know what a stomach is or what energy is? Can he or she plot the relationship of distance and time for a moving object? Does he or she have the writing and speaking skills presupposed in the request to report his or her experimental results?

It is probably impossible to construct a map or model of the entire programme, but even these piecemeal maps or models will prevent many serious gaps. And when gaps do appear, as they inevitably will, when the programme is put into practice, the alert learning facilitator will simply go back to the annual calendars and rearrange the order of activities, or make new activities, not previously thought of, and insert them in the programme at the appropriate place. The design of activities, and the way they are conducted facilitate the detection of gaps. At the head of each study guide, for example, is a list of pre-requisites.

## *Constructing annual calendars*

In constructing an annual calendar, a start is made by making a large chart with 14 columns and 10 rows. The first column is for the grade level, and is followed by 12 columns for the months of the year. The last column is for the total number of the activities to be undertaken during the year. The rows are for years, or grade levels. The squares for the months when the school is closed can be blanked out. Next, all the activities which are season-bound are placed in the squares for the months in which they are to be conducted. The remaining activities are

then placed in the remaining squares according to their relationships to the season-bound activities and to their place in the information, concept and skill maps already prepared. One person should make a draft, but it is necessary for a group of several people to review it critically. Large copies should be posted in the staff room and the principal's office. They will need to be consulted when making the daily timetables for each week. These calendars will have to be reviewed and, if necessary, revised at the year's end in light of experience.

A problem may be encountered when the school is closed in a month when a particular season-bound activity is to be conducted. For example, given our monsoon climate, the times to determine water availability and use are the dry, hot season before the onset of the monsoon (May) and at the end of the monsoon (October) - at least in those areas depending upon the Southwest monsoon. October is not a problem, but schools in the plains close for the summer (May and June). Special arrangements have to be made to conduct these activities on time. Similarly, in the *Our Land Our Life* course, measuring and recording rainfall every day of the year is part of an activity to study rainfall and rainfall patterns. Each school has a rain gauge and maintains a master rainfall register. Learner teams take turns (for one month each) reading the rain gauge after every rain and entering the amount of rainfall in the rainfall register. When the school is closed, the teams whose duty it is in that month must come to the school daily – or at least as many of the team members as possible. They do this even if the learning facilitator comes or not (he or she should come, at least now and then).

## Applying the near-to-far rule

Consider the following set of suggested activities dealing with the general question, 'Where am I?'

1. Our village, city, neighbourhood at a glance
2. Our local (village, neighbourhood, city) ecosystem
3. Our regional ecosystem
4. The Indian sub-continental ecosystem

5. The Earth ecosystem

6. Our solar system and beyond

These activities should be taken up in the order given in grades 6 to 9. Of course, many activities taken up in grades 1 to 5, and even in pre-school, will lay the groundwork for activities 1 and 2 in this list since they focus on the child's immediate surroundings. Or, in other words, activities 1 and 2 make explicit and systematise what children have learned in pre-school and in grades 1 to 5. They, in turn, lay the groundwork for a progressive expansion of the child's horizons that proceeds through activities 3 to 6 in the list.

Consider next the following (also recommended) activities dealing with the past:

1. Our village, town, city in the past

2. Our region in the past

3. The Indian sub-continent in the past

4. Our solar system in the past

These activities deal with the physical aspects of systems of the past, each one focused on a more extensive region than the one preceding it. Each one of these should be taken up only after its corresponding activity in the first list.

Finally, consider this further list of recommended activities:

1. People in the ecosystem

2. Managing our village, town, neighbourhood, city affairs

3. Managing our national affairs

   a. Until the 18th century

   b. 1700 to 1947

   c. 1947 to date

4. Managing world affairs

The activities in list 1 and 2 above are pre-requisites for these activities. For example, activity 3 in list 1 should be followed by activity 2 in list 2 and both should be taken up before activity 3 in list 3.

Each of the activities in the lists given above might actually comprise two or more related activities.

## *Tailoring the programme to local conditions and requirements*

One of the objectives, perhaps the foremost objective, of school education from the point of view of the new protocol is to create awareness in children that in living their lives and later pursuing their livelihood concerns, they must strive to ensure the integrity of the natural systems in which they are embedded. And, more specifically, their education must help them acquire the knowledge, concepts and skills they will need to live their lives and earn their living in ways that do not impair the health of the systems which support them. The UEEC school course *Our Land Our Life* is an attempt to provide such education in one specific setting – the villages of the mountainous region of Uttarakhand state. Anyone intending to create a school programme based on the new protocol should take time to study this course (www.ueec.org.in, 5-year version of the course).

For those wanting to create programmes for any rural area of the country this course will be helpful. For those intending to create programmes for urban schools, activities analogous to those in *Our Land Our Life* can be visualised because the guiding concept of all programmes is the same: the local ecosystem. The exact configurations of local ecosystems vary and each must therefore be carefully defined, but the basic ecosystem structure is invariant.

The urban ecosystem, like its rural counterpart, has been created from a natural ecosystem by human agency. The boundaries of urban and rural ecosystems are drawn to suit human purposes and seldom follow natural landscape features such as streams or river catchments. The structural elements of both rural and urban ecosystems are the

same – land, animals (wild and domesticated), vegetation, people, and the structures people build - though their relative sizes differ. Their functioning in terms of the flows of water, biomass, energy and air are nominally the same though quantitatively different. The important differences between rural and urban ecosystems are six in number.

1. The numbers of people per square kilometre is much greater in urban than in rural ecosystems.
2. Human-made structures (buildings, roads) occupy a larger proportion of the land area in urban than in rural ecosystems.
3. The through-flows of water, biomass and energy are much higher in urban than in rural ecosystems. This is because urban ecosystems produce little or no biomass (food, fuel, industrial raw materials) or water relying largely on imports from other parts of the regional ecosystem in which they are placed, and also because of their higher demands (because of higher human population density).
4. They tend to accumulate wastes (water, biomass, mineral and chemical wastes) or to discharge them into the surrounding areas of the regional ecosystem.
5. The residents of urban ecosystems are relatively more diverse than in rural ecosystems, complicating ecosystem management tasks.
6. Cities are centres of manufacturing which increases the through-flow of water, energy, biomass, minerals and chemicals, and also attract large numbers of people from rural ecosystems as industrial workers.

All these differences between rural and urban ecosystems must be taken into account in constructing a programme for urban schools. A very simplified functional diagram of an urban ecosystem is given in Figure 5.1.

Present-day towns and cities are sick; they are not-functional as ecosystems. Key initiatives to restore them to health are : rainwater harvesting, wastewater treatment and recycling, composting waste biomass, banning of factories that produce hazardous wastes which cannot be recycled, reduction of emissions (from vehicles and factories), and increasing food production.

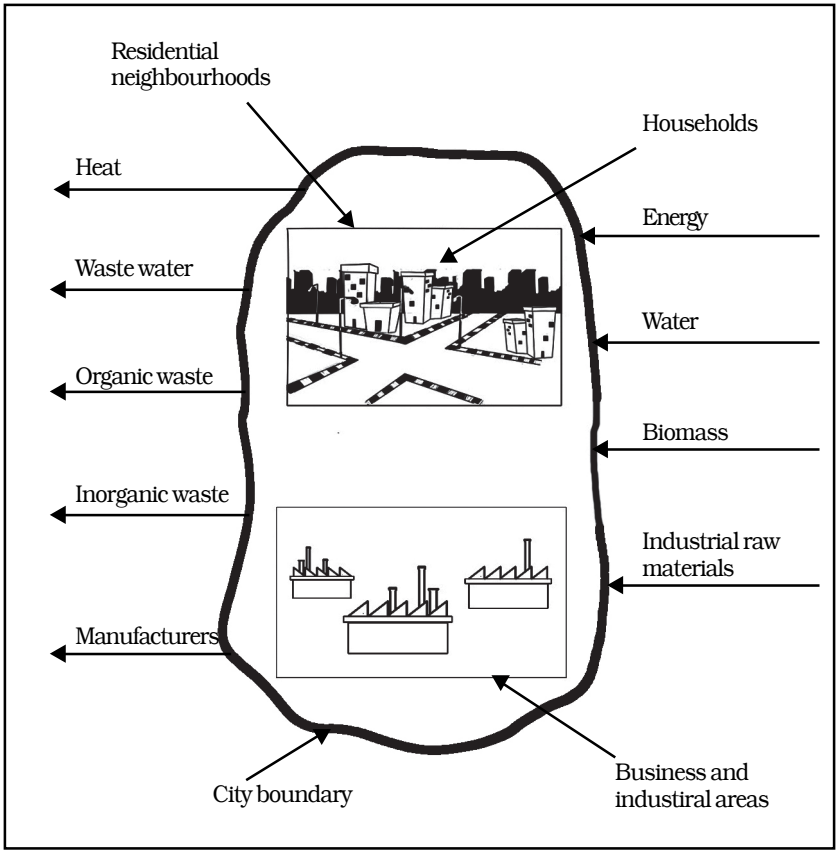



Figure 5.1 An urban ecosystem diagram

A crucial consideration in constructing an urban school programme is how best to develop the ecosystem concept. This is a fairly straightforward task in a rural programme. The rural ecosystem is usually smaller and children, by the age of 10 or 11, have become familiar with the geography of the village in the course of their play and domestic chores and farm work. Because of this, they have acquired a mental picture (a thought thing) of the village as a distinct geographical entity. With urban children of the same age, this is usually not the case. In fact, even for adults, picturing to themselves the city as a definite geographical entity is impossible, except in the case of very small towns. Thus the ecosystem concept cannot be learned at that age by city children.

For effective learning of the ecosystem concept it is essential to begin at a level where children have, or can form, a definite mental picture of the ecosystem in which they find themselves. This usually means starting at the household level.

For gaining a clear understanding of what is meant by the word 'level' in the previous paragraph Box 37.1 from the *Our Land Our Life* course (Appendix 7) will be helpful. An ecosystem, like any other thing, has parts (smaller ecosystems) and is itself a part of a larger thing (a larger ecosystem). In a rural setting we can visualise three levels – household, village and region – while in an urban setting there are four levels – household, neighbourhood, city and region. A start must be made at that level which is an immediate lived reality for the child. This will be the household in all programmes. A start is made at the household level with a variety of activities to measure household rates of production and consumption of food, fuel and water. In the *Our Land, Our Life* course the household-level figures obtained are quickly converted to a per-village basis. As the child has a more or less complete mental picture of his or her village, the more or less full development of the ecosystem concept (that is, the village as an ecosystem) is possible at this stage in the programme by the inclusion of an activity specifically designed for this purpose (See Activity 3, Appendix 4; this activity can be conducted as soon as Activity 7, Appendix 5 is completed.). In an urban setting, this jump is not possible. After acquiring the concept of his or her own household as a system of flows of food, water and energy (electricity and fuel), he or she will have to be led by means of a series of further activities to the levels of the neighbourhood, the city and the region. The child's understanding of his or her household system makes it possible for him or her to conceive of the neighbourhood as a system, as his or her awareness of his or her local neighbourhood as a lived geographical experience develops; the concept of the neighbourhood-as-a-system easily becomes an extension of his or her household-as-a-system concept. This extension process then continues to the city and regional levels. It is only at the regional level that the full ecosystem

concept appears. It appears, that is, only when the city is placed in a regional context. This stage will be reached later in an urban ecosystem, when children are 14 or 15 years old.

## *A few suggestions on programme content in general*

In the 6th to 10th grade portion of the programme, about a dozen activities per year dealing specifically with natural and human-made systems is suggested. All children should participate in all these. This group of activities will make up about one-third of the total activities. Two-thirds of the total activities will be languages, mathematics, artistic pursuits, sports and electives. Space in the programme for electives may be increased progressively from grade 6 to 10, with a maximum of about a dozen activities (or equivalent time for single projects) in a year.

# Appendix 1

## Pesticide Use and Human Health

The following excerpts are taken from school textbooks grades 5 to 12 published by the National Council of Educational Research and Training between 1987 and 1989 (NCERT, 1987-89).

Farmers use insecticides to kill insects and protect their crops from them. Insecticides pose a serious threat to other useful insects, animals and human beings... Therefore it is necessary that we learn to use science and technology with great care, caution and understanding. (*Understanding Environment*, Grade 5, p. 118)

* * *

Spray insecticide such as DDT in your house regularly. Take care that it is not sprayed in excess. (*Understanding Environment*, Grade 5, p. 61)

* * *

At times, pollutants have entered the food chain and have harmed several living organisms. DDT, for example, has entered in almost all the major food chains (Fig. 14.9)... In humans DDT causes severe health problems. (*Science*, Grade 8, p. 222)

* * *

Insecticides have helped in increasing food production by killing insects, but can also be harmful because of their ill effects on man's health... Any technological application thus has a positive and often also a negative side to it. The best strategy is to maximise the positive and to remove all the negative effects. Often this is not easy, particularly when huge investments and profits are involved. The clash is between short term gains and long term environmental safety. Often, steps taken with only short term interests in mind can lead to irreparable damage. The role of environmental protection groups is thus very important. These groups take the long term view, analyse the consequences of each technological process and offer alternative solutions. (*Science*, Grade 9, p. 251)

* * *

It is estimated that there is an annual loss of 30 percent in agricultural productivity owing to pests and diseases. This emphasises the need for using pesticides. (*Biology*, Grade 12, p. 959)

* * *

Some people consider pesticides to be a blessing that allows us to grow more crops, fight diseases and make life more pleasant. Other people call pesticides poisons that are slowly destroying ecosystems all over the world that will end up as a calamity for the human race. Most people hold opinions somewhere in between these two extremes. You should have some information on the controversy, to help you understand the problem better.

Pesticides are poisons. They cannot discriminate between pests and non-pests. Thus, when pesticides are applied in a field, they affect not only the target organisms, but all organisms that come into contact with the chemical. You have studied about food webs in Chapter 21. The food web in a wheat field may consist of several hundred species, most of them insects. A large number of the insects live by attacking the wheat plants. One or two may be so numerous that they can cause severe damage – these are called pests; most, however, are too few in number to cause any damage. This is because there is another set of species that live off the plant eaters, and keep their numbers down. However, these predators are usually much fewer in number than the plant eaters – just as there may be a hundred deer but only one tiger. Applying pesticides to such a field kills both types of animals [*sic*], but because there are many more plant eaters, more of them survive, whereas most of their predators [die]. This results in increased numbers and types of pests. So, applying pesticides could result in more pests than not applying pesticides.

The pests that manage to survive pesticide application are usually the ones genetically capable of withstanding high doses of pesticides. These survivors naturally produce offspring that are more resistant to pesticides. With repeated application of pesticides, a kind of accelerated evolution occurs to produce resistant populations of pests. The development of resistance, as this phenomenon is called, has several grave implications. Farmers are forced to use higher and higher doses of more expensive and more toxic chemicals to protect their crops. This effect is called the pesticide treadmill, where farmers use larger proportions of their income on pesticides, without increasing their yields. This has happened with cotton in India, where some farmers now apply forty times more insecticide than they did earlier just to sustain their yield of cotton. Not only is this economically disastrous, it results in drastically reduced populations of predators, and simplified and unstable ecosystems. Another

example is that of mosquitoes in large parts of India that have become resistant to DDT, BHC, malathion and fenitrothion. As a result, the number of malaria cases is increasing, and the government is forced to spend larger sums of money to control mosquitoes.

Another problem with pesticides is that of bioconcentration. Most organo-chlorine pesticides are highly soluble in the fat of animals. Further these chemicals are quite resistant to being metabolised... In India due to prolonged use of DDT, 13-31 ppm of DDT can be detected in the body fat of people, which is the highest in the world.

There are other problems with pesticides too. These poisons are frequently used by people who are unaware how deadly they are, and lead to adverse health effects. In India, most people using pesticides cannot read warnings and get accidentally poisoned. Further, 'safe' use of pesticides often requires protective equipment like gloves and masks, which the poor cannot afford. Further, lack of stringent measures in the manufacture and storage of pesticides may have grave consequences such as the recent Bhopal gas tragedy.

Some arguments against the use of pesticides were presented above. Are there alternatives to pesticide use? Moving away from the unthinking application of large doses of pesticides, with potentially disastrous consequences, scientists have now accepted that a more ecologically sound way of dealing with pests is Integrated Pest Management (IPM). IPM uses a combination of techniques such as biological control (e.g., using the natural predators of pests to reduce pest numbers), mechanical control (e.g., manually destroying the eggs of pests to interfere with their reproduction), carefully timed use of pesticides at the most susceptible stage of the life cycle of pests, resistant varieties and the use of cultural practices such as mixed-cropping, crop rotation, intercropping and crop cycles lasting several years.

The 'new-found' wisdom of IPM has its origins in indigenous knowledge and traditional farming practices developed by farmers over centuries of experimentation and experience. Scientists are realising that 'traditional' does not mean 'backward' and that they have much to learn from farmers. Most farmers in India still use such methods – locally developed varieties adapted to local conditions and pests, intercropping, crop rotations, etc. These methods are part of a wider strategy, now called 'organic farming', which does not disrupt local ecosystems, and leads to sustained yields at low cost, both to the farmer and the environment. Farmers in western countries have gradually shifted back to such methods as they realise that dependence on pesticides make their farming non-sustainable in the long term. (*Biology*, Grade 12, pp. 962-5)

# Appendix 2

## Who is responsible for our environmental problems?

The following excerpts are taken from school textbooks for grades 5 to 10 published by the National Council of Educational Research and Training. These textbooks were published between 1987 and 1989 (NCERT, 1987- 89).

Grass, shrubs, other plants and trees protect the top soil from the rains, running water and wind. When trees are cut down, the top soil is exposed. It gets easily washed away by water. It is also blown away by winds. Therefore, we should stop indiscriminate cutting of trees and thus help protect our forests... grazing animals such as cattle, sheep, goat, etc. eat grass. When these animals graze on the same piece of land year after year, the grass cover gets destroyed. To avoid this, such animals should not be allowed to graze in the same field continuously for a long time. (*Exploring Environment*, Grade 5, p. 72)

* * *

Similarly, scientists have found out that overuse or misuse of chemical fertilisers is also harmful to crops and human health. (*Exploring Environment*, Grade 5, p. 118)

* * *

Indiscriminate use of pesticides and fertilisers can lead to environmental degradation. (*Science*, Grade 8, p. 174)

* * *

Rise in living standards has led to over-use of resources. As income increases, people buy and use more but what is worse is that at times they are wasteful in their habits. (*Science*, Grade 8, p. 222)

* * *

In recent years, felling of trees from these regions has been on a very large scale... With the devastation of these forests, the soil has been eroded, the rainfall has been reduced and the climate is altering. (*Science*, Grade 9, p. 250)

* * *

A not so desirable by-product of the Green Revolution has been the creation of ecological imbalances. The soil has become fertiliser-dependent. The new crop plants demand more water for which the existing natural regimes of water are artificially altered. They have also become more dependent on pesticides. Excessive use of these chemicals, in turn, affects soil fertility and human and animal health. (*Science*, Grade 10, p. 60)

# Appendix 3

## Who will solve our environmental problems?

The following excerpts are taken from the school textbooks for Grades 5 to 11 published by the National Council of Educational Research and Training. They were published between 1987 and 1989 (NCERT, 1987-89).

We should plant more trees since green plants enrich the air with oxygen. (*Exploring Environment*, Grade 5, p.81)

* * *

Chemical factories often produce toxic chemicals as wastages. In most of the industries these are not properly treated before throwing them out. This industrial waste is discharged into rivers. The river water thus becomes poisonous for the fish and river plants. A flowing river can purify a certain amount of its water by natural processes. And many industrial waste products cannot be cleaned easily by natural processes. The water stays polluted and causes several diseases to people who use it... Control and removal of polluting substances need to be done... the Indian Government has taken up the task of purifying the river Ganges. This is being done by treating the sewage in all towns and cities on the banks of the river. This treatment makes the sewage water harmless before it is released in the Ganges. The industrial wastes will be initially treated in the factories. The treated water is then let out into the river. Along the banks of the river will be planted many trees and shrubs. These not only add beauty to the scenery but also help in cleaning up the environment. (*Science*, Grade 7, pp. 100-101)

* * *

In refineries and power plants, it is thus important to remove the oxides of sulphur and nitrogen before the gases are let out. Otherwise, these will be carried in the wind and rain and will produce what is called acid rain. Acid rain will damage cement, steel, marble, bricks and, of course, living organisms... With more industry and progress, the pollution of the air

would become a problem. Wisdom lies in anticipating these problems and solving them before they cause damage. The Mathura refinery is such an example. Here the problem was anticipated and solved so that the Taj (Mahal) at Agra is not damaged by acid rain. (*Science*, Grade 7, pp. 108-9)

* * *

To preserve forests man must stop the process of deforestation, which is mostly due to excessive felling of trees, overgrazing by cattle and mining. These human activities cause severe soil erosion which within a few years can destroy a forest completely. (*Science*, Grade 8. p. 218)

* * *

Remember, it takes decades for a tree to grow to its full size, but just a day to cut it. These trees provide the appropriate climate, soil consistency and ecological stability to the hill regions. With the devastation of these forests, the soil has been eroded, the rainfall has been reduced and the climate is altering. Rivers change their course, flooding the regions very often. Landslides occur frequently. Since the rainfall is erratic, drought becomes frequent in the plains of U.P. and Bihar... One way of regaining the balance here is to reforest the area. The government and the people of the region are attempting to do so at present. Often, such damage can become irreversible. It is a pity since man; the thinking animal is responsible for this denudation. (*Science*, Grade 9, p. 250)

* * *

Unauthorised felling of trees for timber trade and for fuel consumption should be curbed immediately and for every acre of forest cut down an equal area should be planted with saplings. (*Science*, Grade 10, p. 176)

* * *

Control of land loss can be attempted through restoring forest and grass cover to check erosion and floods. Shifting cultivation can be replaced by crop rotation, mixed cropping or developing plantation crops which would improve fertility and support a larger population.

Salinity can be prevented by providing the flood-prone and irrigated lands with adequate drainage. Salt affected lands can be recovered by leaching them with more water, especially where the ground water table is not high. Shifting sand can be controlled by mulching (use

of artificial protective covering) or covering the area with appropriate plant species and by raising trees as windbreaks...

The treatment of catchments should be done on an environmentally sound basis. It must begin from the top-most reaches of the catchment. The land to be conserved should be planted with economically and socially useful trees and grasses, chosen according to edaphic and climate conditions and local needs.

The productivity of canal irrigated lands in India is still very poor in comparison with that in other countries because of water-logging and salinity. Proper drainage and desalination practices can overcome these problems...

Reclamation of wasteland that is reclaimable within the financial means and known techniques should be immediately undertaken. (*Biology*, Grade 11. pp. 370-72)

# Appendix 4

## Sample activity guides

The numbers of the activities in this appendix are for convenience in referring to them in this book. Their numbers when they form part of a particular programme will depend upon their placement in the programme annual calendars. They are adapted from exercises 1, 4 and 5 in the school course *Our Land Our Life* (www.ueec.org.in), respectively. In the latter activity (Learner Handout 3.2) the children's references to 'My vegetable garden' refer to the gardens the children maintain at their homes as an activity in their *Our Land Our Life* course.

# Activity 1. Our village at a glance

## Concepts and skills to be developed

This activity is designed to promote the acquisition of the following concepts by students:

1. The village is a definite, identifiable geographical entity, that is, it has a boundary marking it off from other geographical entities.
2. The village as a whole is the focus of interest and activity in rural life – and in this school curriculum. Other geographical entities like farms and fields, while important, are of secondary concern. This is because these smaller entities are ultimately dependent on the larger entity for their health and productivity.
3. A map is a visual representation of the village, a drawing on paper or on the ground. It shows the relative spatial positions and sizes of the main subordinate entities like hills, valleys, water bodies, fields, houses, civic or community buildings and roads. It may be a two-dimensional or a three-dimension representation.

This activity is also designed to provide practice in, and the further development of, learners' skill in free-hand drawing. As with all other activities in this programme, is also designed to provide practice in, and the further development of, learners' ability to work together in small groups and within the entire class to accomplish a common task.

Learners are not to be told what the objectives of the activity are. The activity is designed to help them develop these concepts and skills naturally in the course of participating in the activity. Their work in the activity will indicate the extent to which they have acquired them.

## Procedure

1. Make teams of students for the small-group learning parts of the activity. Each team can be of three to five members. The number of teams should be

between five and ten. Ensure that there are boys and girls in each team, and that each team has at least one of the faster learners and at least one of the slower learners. These teams should be formed on a yearly basis. In general, it is best not to cater to the childrens' preferences in forming the teams.

2. As a preliminary, warming-up activity, ask the children to sit together team-wise and to draw a map of the classroom, showing all the main features like childrens' desks and chairs, facilitator's table and chair, *almirahs* and so forth in their proper places relative to each other and their relative sizes. Give them a time limit for this task. Then ask a member of one team to come to the blackboard and make a copy of his or her team's map. Discuss this map with the class and make changes, improvements as may be suggested by other teams – and by you.

3. In the main activity, each child will draw a village map in his or her worksheet. Then, working in small-groups they will prepare a large-scale map on a chart paper. Finally the whole class will prepare a still larger map on the ground, individual teams being assigned specific tasks by the facilitator. If the village land is undulating, they will make this latter map three-dimensional.

4. The village selected may be the village where the school is located, or a nearby village.

5. Walk around the perimeter of the village with the class, looking at it from all angles. If the village is in a hilly or mountainous region, go to one or more high parts of the village to get an unobstructed view of the whole. If necessary, you may invite one or two village residents to accompany you to explain various features of the village. Find a comfortable spot and ask the learners to sit down and draw a map of the village on their worksheets. This is to be done by each learner individually.

6. On returning to the classroom, ask the children to work as teams to prepare a larger-scale map on a chart paper, working from the sketches they made in the village. Ask one member of each team to present his or her team's map to the class. Display all these maps, compare and discuss them with the class as a whole. Make a single final version of the map on the blackboard and

ask the children to make a copy of it. A few children, say one from each team, may be asked to make a large copy of this on a chart paper to be put on the wall of the classroom for future reference.

7. The final phase of this activity is making a large map on the ground in the school yard. This should be large enough so that the entire class can stand around it when finished and easily see all parts of it. Suppose the village is roughly square in shape; the map should then not be smaller than about 2 x 2 metres. Make the map according to the final version of which the children have made copies. This is a whole class activity, but individual teams may be assigned specific tasks. Begin by making the outer boundaries. Be sure that the map has the same North-South orientation as the village itself. Pile up soil to make hills. Mark the boundaries of the map with stones to make them permanent. Whitewash pieces of brick to show houses. Place stones and sticks to depict other features of the village such as wells, springs, roads and canals, cultivated fields, uncultivated land (village forest and grazing land), numbers and positions of trees. If the finished model is plastered with cow dung it will not get washed away when it rains. The model may deteriorate with rain and so it will have to be repaired from time to time. Be sure the model is protected from trampling by animals. The model will be used in many future activities.

## Requirements

1. Large-sized, white chart papers, one for each team
2. Sets of coloured sketch pens, one for each team
3. A few hand, soil working tools and iron basins to carry soil
4. A piece of string to mark out straight lines
5. A good supply of sticks, stones, pieces of brick and wood and small tree shoots (to represent trees)
6. Lime to whitewash brick pieces used to represent houses

## Suggested questions

1. *What is the approximate proportion of cultivated and uncultivated land in your village?*

2. *Look at your model and describe the condition of uncultivated land, that is, the type of vegetation (grass, trees) and its density.*
3. *Which of the water sources in your map is used for domestic purposes and which for irrigation?*
4. *What is the proportion of irrigated to un-irrigated land in you village? Have you shown this in your maps?*
5. *If there are some fields which are not irrigated, why are they not irrigated?*

Ask the learners to write down the answers to these questions. They should do this individually in the classroom. Collect all the learners' worksheets and file them.

# Activity 2. Our village in the past

## Concepts and skills to be developed

Learning about the past is a matter of investigation and interpretation. Learners will thus attempt to gain knowledge of the recent past of their own village by tapping the most readily-available resource: the memories of the older residents. These will include their personal memories and the memories of their ancestors. Learners will learn how to interview people to obtain information, and then how to collate and interpret this information. Further, they will be asked to reflect on the contemporary relevance of this information. Finally, they will have their first lesson in planning an activity and in recording their findings.

## Procedure

Begin this activity by distributing Learner Handout 2.1. After the children have read it, devote a class period to discussing it.

Question 1 is to be undertaken by teams. In making their plans, be sure that they include interviews with both men and women, since the two often have different perspectives on the village past. Here is a list of questions that might be considered in determining the topics for interviews:

1. Why did our ancestors settle in this place? What were their considerations in deciding where to build their houses?
2. Were there more trees in the village before than there are now?
3. Are the types of trees in the village earlier different from those today?
4. Was there more irrigated land in the past than today, or less?
5. When the old people of the village were young did people use chemical fertilisers and pesticides in their fields?
6. From where did village people in the past get seeds? From where do they get them now?
7. Were crop yields more than now, or less?

For organising their information (Question 2), here is a list of suggested headings that the students might use:

1. Trees
2. Number of families
3. Water
4. Types and yields of crops
5. Proportion of cultivated land to total village land
6. Types and numbers of domestic animals
7. Types, numbers and behaviour of wild animals and birds
8. Duration and intensity of rainfall, snowfall
9. Customs and lifestyle
10. Landscape changes
11. Any other

Special features of the village (see Question 3) that might be investigated are:

1. A hill
2. A river or stream (also mention where does it come from and, where does it go)
3. A famous old tree
4. A sacred grove
5. A temple, mosque, gurudwara or church
6. A road (from where, to where; who built it)
7. A school
8. A hospital or dispensary
9. The village women's group and youth group (when and why were they started)

Suggest to the children that they might investigate any stories and myths associated with any of these features. Stories and myths might even be dramatised.

## Questions

1. *How will you find out what your village was like in the past, before you were born, or even before your parents were born? Describe the procedure you will follow. Also, make a list of what specifically you would like to know. Present you plan to the whole class when requested to do so by your facilitator. The plans of all the teams will be presented and discussed, and one general plan will be decided which will be followed.*

2. *Your facilitator will assign different teams to carry out different parts of the general plan. Now record the information you have obtained on your worksheet. Is it similar to that of other teams? If not, why do you think it is different?*

3. *Make a list of some features of your village which are of particular interest to you. How will you investigate these? Your facilitator will assign one feature to each team. After completing your investigation, write a short essay describing the past of that feature of the village which you were assigned. Read this out to the class when requested to by your facilitator.*

## Learner Handout 2.1

# The stone axe - how our village was

Shyam is studying in Grade 6. His village is located on the bank of a river. Two days earlier there had been a heavy rain and the rushing water of the stream had scoured the banks, exposing fresh soil. Yesterday as he was plying near the river, he saw a stone sticking halfway out of the soil and he picked it up. The stone looked like this.

He examined it carefully. One of its edges was quite sharp. He took it home and showed it his father.

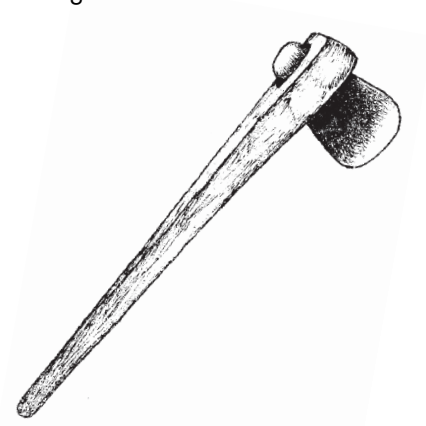
After looking at it for a while, his father said, 'I think that someone made this from a naturally-occurring stone by chipping off pieces. I have heard that people long ago made stones like this for cutting things. At that time they did not have metal for making cutting tools. But why don't you show this to Professor Sahib? He should be able to tell you more about it.'

Professor Senger was a scientist who had worked in the Archaeological Department. After his retirement he came back to his native village to live. He was surprised and delighted to see the stone Shyam showed him. He exclaimed, 'Shyam, you have found a stone axe head used to cut trees by people who lived in this area some four thousand years ago.

I have myself found many of these when I was excavating prehistoric village sites at Lodhwara, Chaakla and Banka in Banda District, Uttar Pradesh.'

Professor Sahib further explained, 'This type of tool was made by hitting a round stone in a certain manner with another, harder stone, breaking off chips. Then the thin edge was made sharp by grinding against another hard stone... Finally the stone was fitted with a wooden handle to make an axe.'

At the same time he took a book down from the shelf and showed Shyam a picture of a stone axe. He said, 'With such axes they were able to cut down big trees, thus clearing the land for growing crops. This means, Shyam that this axe head was probably made by the people who established this village – our ancestors.'



Shyam listened eagerly to what Professor Sahib was saying. He had never thought about his ancestors beyond his grandparents. 'What would our village have looked like 4,000 years ago,' he thought. Just then Professor Sahib's wife brought some mangoes from her garden. She sliced them and offered the pieces to Professor Sahib and Shyam.

Perhaps Professor Sahib read Shyam's thoughts, for he said, 'Can you imagine Shyam what our village looked like 4,000 years ago? Of course no one knows all the details, but from old manuscripts and excavations of prehistoric villages we know that the whole Ganga basin was then covered by dense forest. The people who came here to live knew how to grow crops. But they had to clear the forest in order to do so.

'In the first few years the crops were very healthy and yielded a lot of grain, but thereafter yields declined. The settlers realised that if the fields were to feed them, they would have to feed their fields. This they did by putting the dung (compost) from their cattle in the fields. In this way the soil remained healthy and gave good yields.

'Of course, many trees remained even after clearing the forest near their houses. They brought fuel wood, stem wood (for making houses and tools), fodder and bedding leaves for animals from the forest. They obtained milk from cows and buffaloes and used bullocks to plough their fields. Animal dung and used bedding were made into compost to feed the soil of their fields. They and their animals were totally dependent on these forests.'

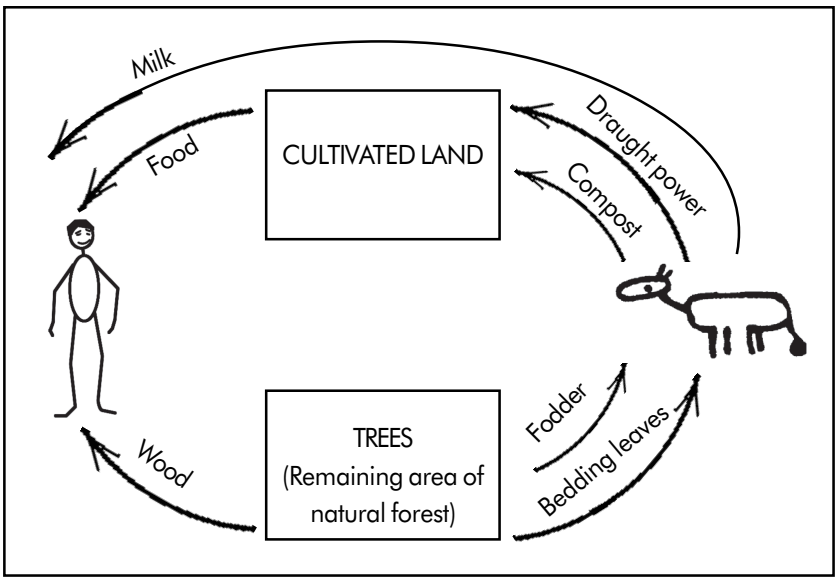



Figure 4-1-1

Professor Sahib explained all this with the help of a simple diagram.

'This was the basic pattern of village life everywhere in India in the past. The land remained productive as long as the trees remained.'

Shyam said, 'Professor Sahib, now there is no forest in our village. There are only cultivated fields, the grazing land (*charagah*), and some

wasteland (*banjar bhoomi*) along the stream. There are only a few isolated trees here and there. I understand that some trees had to be cut down by our ancestors to make fields to grow crops. You have explained that some trees, however, are necessary to grow good crops. Then why have we cut down almost all the trees in our village?'

'Well Shyam, I don't think our ancestors realised the great importance of trees. They had so many of them that perhaps they could not imagine what it would be like not to have any. Now that we no longer have any trees, we realise their importance. As the population of the village increased, people cut more trees to make more fields for growing crops. They did not realise that more cultivated land will not produce more food if there is less compost. Also, they didn't seem to notice that when our animals graze in forest they eat or trample tree seedlings. Thus when old trees died or were cut down by us, new trees did not take their places. Gradually, the village lost all its trees. Our present-day grazing land and wasteland were both village forest in those days, giving people fuel wood. Now we do not have wood for our cooking stoves (chulhas). What do we burn instead?'

Shyam said, 'We burn animal dung. This means that the dung which should feed our fields is now burned. It means that the soil in our fields is not as healthy as it was before.'

'Yes Shyam,' replied Professor Sahib. 'I remember that when I was young our crops were very poor: the soil was starved. In those days too, like now, there were hardly any trees left.'

Old Harpal Singh, a farmer, Professor Sahib's neighbour, had listened to their conversation. Now he came over to join them, and said. 'I too remember how poor our crops were when I was young. But then we did not realise why they were poor, because we had not seen any really good crops. Of course, we know that more compost gives better crops, but we did not connect trees and compost.'

Harpal Singh continued, 'When I began to use fertilisers crop yields increased greatly. But now, some thirty years later, I see that the production of my fields is declining. Professor Sahib reminds us that we once had many trees in our village and therefore crop production was sustainable.

Now we have to start thinking where we can plant trees in our village so that we can get enough compost for our crops.'

Professor Sahib said, '*Bhai* Sahib, I think you are right. I am sure that youngsters like Shyam will begin this work.'

It was time for Shyam to go. He said, 'I wish all my classmates could come and talk to you and *Dadaji* about our village in the past and what we must do in the future.'

'You are always welcome, Shyam,' said Professor Sahib. 'Take good care of your stone axe head and be sure to show me anything else like this you may find.'

# Activity 3. Our village ecosystem

**Pre-requisite**

Activity 2 in Appendix 4 and Activity 7 in Appendix 5

**Concept to be developed**

In activity 1 learners made a village map. These maps are diagrams that show the spatial relationships among the various physical things in the village. In this activity they will make a diagram of the village ecosystem. This diagram will show the inter-relationships among these same things. The concepts underlying these two types of diagrams are thus different. Moreover, while this diagram will be that of a system, it will be of a special type of system: an ecosystem. The addition of the prefix 'eco' to the word 'system' serves to distinguish this type of system from others like the body of an animal or plant. The difference is that the word 'ecosystem' refers to a clearly-defined area that is a part of the larger earth ecosystem.

The parts of an ecosystem are land, water bodies, plants, animals, insects, micro-organisms and people. To make the construction of the diagram manageable individual plants, animals, insects, micro-organism and people are not shown, but only groups of these. Thus in our present activity we will group all plants into two categories, forest plants and cultivated plants. Similarly, animals will be farm animals, and people will be the village community as a whole.

This activity is thus intended to help learners grasp the concept of a village ecosystem diagram; that is, they will be helped to formulate this concept for themselves.

**Procedure**

The 'concept in brief' given above is to provide you a general orientation to the concept of the village ecosystem diagram to enable you to ensure that the activity proceeds towards the intended goal. It is not to be used as a basis for a lecture.

The questions are given in Learner Handout 3.1. Give each learner a copy. These questions are to be taken up by learners working in teams initially, and finally answered in general class discussions. While the teams are working, move about the classroom, visiting each team to look at the progress they are making. If

they are having problems it may be appropriate to give them a hint – in the form of further questions.

After completing the final ecosystem diagram, give the children copies of Learner Handout 3.2. Allow them half an hour to read it by themselves. Then ask them to find a solution to the problem in the handout, working in teams. Give them sufficient time to formulate their solutions and then ask one member of each team to present their team's solution to the whole class. Discuss these and try to reach a consensus on how to solve this problem. The children should each write an ending to the story on their own along the lines of the consensual solution arrived at in the whole-class discussion. Ask a few children to read out their story endings to the class.

The context of this story is the irrigated North-western Ganga plains where there is now widespread environmental deterioration. A reference is made in this story by Zarina to an elective project on vegetable growing she is pursuing at home.

**Requirements**

Large (55x70 cm) chart papers, and black (sketch) pens, one of each for each team in the class.

## Learner Handout 3.1

# Questions

In this activity we will construct a systems diagram of our village. A systems diagram shows all the parts of a system and also shows the relationships among them. Begin by making a list in your notebook of the parts of the village you wish to show in your diagram and discuss them with your team members. Of course, you cannot list every part because there are too many. But you can group them according to the main types of things such as people, trees and so forth. When you have finalised a common list for your team, your teacher will ask you to share your list with the class. When the class has finalised a common list, make a copy in your worksheet. You are now ready for the second part of the activity.

1. Make a diagram that shows the relationships among the various parts of your village in your worksheet, discussing it with your team mates in order to arrive at a common diagram. Before making the diagram decide what relationships exist among the various parts that you decided on. Here is a hint: cows eat grass, tree leaves, straw, and kitchen scraps; cows give milk which people drink. Now how will you show these relationships in a diagram? Make some sketches on your worksheet and compare them with those of your team mates. When you have a common diagram, show it to your facilitator and get his or her comments and suggestions.

2. Now make your diagram on the chart paper you have been given. When requested by your facilitator, present it to the class. After all teams have made their presentations, there will be a general class discussion to finalise one common diagram which we will use in all

our further activities. Make a copy of this common diagram in your worksheet.

3. Your diagram is called an 'ecosystem diagram'. Why has the prefix 'eco' been added to the word 'system'? Do you know what it means? Here is a hint: it is derived from the Greek word 'oikos' which means 'house'. What does this suggest to you?

4. In a system, everything depends upon everything else. What would happen if the people of the village sold all their farm animals? Make a new diagram, leaving out farm animals. Compare your new diagram with those of your team mates.

5. Animals produce waste. Is it really a waste? What happens to it? Is it useful? How? Write down your answers on your worksheet.

6. Human beings also produce waste. Have you shown this in your diagram? Does it have any value? Explain.

7. What is the role of trees in the village ecosystem? What happens if all the trees are cut down? Hint: what did Professor Sahib say about this (Learner Handout 2.1)?

8. Who will volunteer to make a final village ecosystem diagram which can be displayed on the wall of your classroom?

## Learner Handout 3.2

# Pests

Aruna is in the 6th Grade. From last evening she had been very worried. This worry accompanied her to school this morning. When she was doing her homework last evening she saw that her father was very troubled. He said to Aruna's mother, 'This year we bought a very expensive new pesticide because the one we have been applying for the past three years has become ineffective. This year we will also have to buy more fertiliser. To maintain the same yield we have to apply more fertiliser every year, and the cost of fertiliser is also increasing steadily. The cost of growing crops is increasing year by year.'

Aruna's elder brother Rajpal (who is in the 11th Grade) said 'In our science textbook it is written that insects develop resistance to insecticides so that the insecticides have no effect on them.'

Aruna's grandfather was listening to all this. He said to his son 'Long ago I told you not to use fertilisers and pesticides, but you didn't listen to me. When I was farming I never used these things. Today, though you are spraying more and stronger pesticides, crop damage continues to increase. These chemical fertilisers stimulate the growth of our crops, but the plants are not healthy and this is why they cannot resist pests and diseases.'

In reply Aruna's father said 'When I first used chemical fertilisers our crop yields more than doubled, and I thought we could earn a lot of money, whereas today we don't have money even to buy fertilisers and pesticides. Many people are in an even worse condition than we are.'

Thinking about this Aruna was on her way to school this morning when she met Mahipal who was a team mate in her *Our Land Our Life* course at school. She told him about her family problem.

After listening to Aruna's story Mahipal said 'A few days ago my father and I discussed a similar matter. He applies chemical fertilisers and sprays pesticides. I told him that it is written in our science textbook that the pesticides we use to kill insects in our crops and vegetables are poisonous for us too. They cause many diseases. When we spray these pesticides we breathe in some amount of them. Scientists have found that they are present in all the foods we eat every day. They are even found in cow and buffalo milk.'

'My father said "What can we do? If we don't spray these pesticides our crop yields will go down due to insect damage. Further, if vegetables like eggplant and cauliflower are damaged by insects we will not get a good price for them."'

'He also said "Why are you troubled by all this? We do not spray pesticides on the vegetables we grow for our own use." This sentence of my father troubled me still more, and I asked him if it is right for us to eat vegetables free from pesticides while growing them with pesticides for people in the city. He had no reply to this question.'

Further on, Aruna and Mahipal met Zarina and Mahendra. They too were members of Aruna's team. Aruna and Mahipal told them of their problems.

Zarina said 'I don't think there will be any pests in my vegetable garden. And my grandmother tells me that even if there happens to be any pests, she knows of many natural control measures of them. She says there is no need for me to worry. She said "For centuries people are using neem leaves as an insect repellent." She said that if everyone were to grow crops in a natural way using compost or mulch crop plants would be healthy and there would be no need to spray them with pesticides.'

On hearing this Aruna, Mahipal and Mahendra agreed that they too had no pest problem in their vegetable gardens. All four of them applied compost in their gardens. With one voice they said that if their fathers were to apply compost in their fields the problem of pests could largely be solved. For a few minutes they were all quiet. Then Zarina said 'Our

gardens are very small and we prepare enough compost for them, but for big fields a lot of compost will be needed. How can so much compost be made? We use most of the dung from our animals as fuel.' None of them had an answer to this.

'Do you know,' said Mahendra, 'two days ago my father and my brother Prem (Mahendra's brother Prem studies agriculture at the university) were discussing these very problems. Prem said that the real problem with the use of fertilisers and pesticides is that farmers do not understand scientists' recommendations: they need to be trained. Then my father took out a copy of a university publication on how to use fertilisers and pesticides, and, showing it to Prem, and said, "I am following these recommendations for many years. In the beginning, I won a prize one year for the highest paddy yield in the district, but now I am seeing that year-by-year our production is falling. Now tell me, what should I do?"'

Mahendra continued, 'When this discussion was taking place our neighbour, Sita aunty, was talking to my mother, and she joined in, saying, "Do you know what the problem is? These new hybrid varieties are like a person addicted to a narcotic; they cannot grow without fertiliser. In the beginning the seed companies convince you to buy their seeds, and then you have to buy their fertilisers and pesticides as well." Continuing, she said, "Some days ago Kamala's father (Kamala is her daughter, that is, she was referring to her husband) and I were saying that our old paddy variety, the one we inherited from our parents, with enough compost, yielded as much as we are getting today."

'At this point Kamala's father, Sukhbir Singh, joined us and said, "But the problem is that we no longer have seeds of the old variety."'

'"I have heard," he continued, 'that Sardar Gurubachan Singh has seed of an old paddy variety. It gives a good yield and also doesn't require as much water as the new varieties. With these new varieties we are pumping too much water and our wells are going dry. I am thinking of going to Sardarji; maybe I can get some seed from him."'

'Everyone was quiet for a while. Then Sita Aunty said, "With that old variety we will need a lot of compost."'

Aruna asked the others 'What is the solution to this problem?'

Talking together in this way they arrived at their school. There was 15 minutes left before the first period. The four team members saw their teacher, Mrs. Sharma, and decided to ask her the solution for the problem they had been discussing.

Mrs. Sharma listened carefully as they told her about their problem. Then she said 'I think this is a problem that the whole class should discuss. Perhaps we can find a solution.'

# Appendix 5

## Foundational activities for the study of natural phenomena

The numbers given to the activities in this appendix are for convenience in referring to them elsewhere in the book. Their numbers when included in any particular programme will depend on their placement in that programme.

# Activity 1. What are things? What kinds of things are there?

## The concept in brief

During our waking hours we are continually aware of something or other in our surroundings, as well as of thoughts, emotions and sensations within ourselves. We will call all of these by the common term 'things'. Each of them is a discrete entity, an object experienced by me. Thus I say 'I see this thing', 'This idea occurs to me', 'I am frightened', or 'I have a toothache'. The appearances of these things are momentary. No sooner do they appear than they disappear. They follow one another so rapidly that a series of similar things appears to be an enduring entity, only differing from one another slightly. Each person's world is made up of all the things he or she has experienced in life. Thus not everyone's world is the same, though they are all similar.

## Procedure

The 'Concept in brief' above is given to provide you a general orientation to the concept of things to enable you to conduct the activity more effectively. It is not to be used as a basis for a lecture.

The objective of this activity is to formulate a general concept of a thing, and also the concept that there are distinctly different kinds of things. In order to do this it may be necessary to question some commonly-held, present-day assumptions, and maybe even discard them. As facilitator, you will ensure that a consensus is reached by the class, and, in particular, that present assumptions are, if necessary, rigorously questioned. Some questions you might use in conducting this activity are suggested below. Questions 3 to 5 are elaborations of question 2. Other questions will suggest themselves as the classroom discussion proceeds. Do not neglect to ask them, and be sure that each one is answered to your and the children's satisfaction. If it is necessary to discard present assumptions, the class will have to formulate alternative assumptions which seem more logical and useful than the present ones. Devote as much time as is necessary to come to definite answers to the questions posed. To help keep the discussion focused, definitions of some of the key words to be used are given in Learner Handout no. 1.1 below.

After learners attempt all six questions give them student Handout 1.2. After they have read it ask them to summarise in writing (100 words) what they have understood from it. Call on a few children to describe their understanding to the class. Then hold a final discussion aimed at arriving at a consensus on the nature of things.

Ask the children to write down in their worksheets each of the questions asked, and at the conclusion of the activity, the answers agreed to by the class. If anyone disagrees with the majority view, he or she should be encouraged to write it down as well, clearly labelling it as their own view, and giving reasons for his or her disagreement.

## Suggested questions

1. *You will agree that there are many things in our classroom at the present moment. What are they? (Make a list of these in your worksheet and share them with the class when requested to do so by your teacher.)*
2. *All the things in your lists are what are called physical things. Aside from physical things are there any other kinds of things in our classroom at this time?*
3. *Just now it suddenly occurred to me why my classmate Sita got annoyed with me on the bus this morning. Is this sudden understanding also a thing in our classroom at this time?*
4. *I was thrilled to learn my test score just now when Ms. Pande returned our corrected copies to us. Is that thrill a thing in our classroom at this time?*
5. *Today I have a toothache, and as a result I cannot concentrate on the activity. Is this toothache a thing in our classroom at this time?*
6. *If thoughts, emotions and feelings are not things, then what are they?*
7. *If they are things, where in the classroom are they?*
8. *If physical objects, thoughts, emotions and sensations are all things, even though they differ one from another, then what do they have in common? (If they do not have anything in common we are not justified in calling them all by the same name.) Or to phrase the question in a simpler way: what is a thing, really?*

## Learner Handout 1.1

# Definitions of some words to be used in this activity

An **assumption** is an explanation for a fact, situation or phenomenon which is accepted because it seems likely, but for which there is no factual evidence.

An **experience** is to become aware of an object.

A **fact** is something which cannot be denied or disputed. The objects that appear in experience are facts.

A **physical thing** is an object of an experience that we can see and/ or touch. It appears to be outside ourselves.

In every experience there is an 'I' that experiences and an object that is experienced. All objects are termed **things**.

## Learner Handout 1.2

# Things are momentary appearances

Indian Buddhist philosophers of the third century AD said that all things, both those in our surroundings (physical things) and those that seem to be inside us (thoughts, emotions and sensations), are momentary appearances. They termed these *dharmas*. They follow each other rapidly; each one is as brief as the 'wink of an eye'. One thing no sooner appears than it is superseded by another. The flame of an oil lamp at this moment is not the same as the one that appeared a moment ago, though it is similar. These separate experiences follow one another so rapidly that it seems to us that it is one continuous, though continually changing, thing. And so it is with all things.

Similarly, the Greek philosopher Heraclitus in the 5th century BC said 'You cannot step twice into the same river,' meaning that it is not the same river moment to moment, but a completely different one. In other words, things do not change, they only appear to do so; actually they only appear and disappear.

Today scientists trying to understand how we come to know things (the science of cybernetics) have reached the same conclusion. The world, they say, is constructed by each of us from the experiences he or she has. However, your world and mine are similar, even if not the same.

# Activity 2. Things and parts of things

## Pre-requisite

Activity 1

## Concept in brief

In every thing it is usually possible to discern parts. A book, for example, has pages, and pages, in turn, have words printed on them, words are composed of letters, and letters, too, have parts. Or take as an example a feeling or sensation thing such as the distress suffered when I have flu. It is made up of several separate and distinct sensations: chills, nausea, rapid pulse, and a sore throat. A worldview (a thought thing) consists of several distinct concepts such as the livingness of all things, the inter-connectedness of all things, learning by reflecting on experience, and others. In my love of my country (an emotion thing) it is likewise possible to identify several component emotions: the love of the mountains where I live, my love of the family of which I am a member, the awe and admiration I have towards the founders of my country. We will generalise from these examples and say that everything has parts. If we cannot identify the parts of a thing we are not justified in concluding that there are no parts; maybe the parts are so small that we cannot detect them. We cannot be certain that there are no parts of any particular thing.

It is also usually possible to discern a larger thing of which the thing in question is a part. The oblong piece of wood I am looking at is a part of a larger thing called a table. The memory of Meera, a thought thing, is part of the larger thought thing of the family get together last night at which I met Meera. If we cannot discern or even imagine a larger thing of which the thing is a part, it does not mean that there is no such larger thing. We can never prove that there is no larger thing.

From these considerations we will assume that:

1. Everything has parts, and is a part of a larger thing;
2. There is no smallest thing of any kind, a thing which has no parts, and which is only a part of some larger thing;
3. There are no largest things of any kind which are not themselves parts of

some larger things. There are no ultimate or final things, beyond which there are no larger things.

Like all assumptions, these cannot be disproved by further experience. If they are useful, we may accept them. It is not useful to assume the opposite, that there are final things, and never be able to find them.

## Procedure

The general procedure for conducting this activity is the same as for activity 1. It is suggested that question 4 be undertaken by teams in the first instance. A member of each team may then be requested to present his or her team's agreed lists to the class. Invite other members of the class to comment on these, and to offer suggestions. This activity is to be considered complete when a consensus of all the members of the class, and the facilitator, is reached on the answers to questions 5 and 6. Ask the children to record these answers in their notebooks.

## Suggested questions

1. *One of the things most of you have put in your list of the things in the classroom in Activity 1 is 'desk'. A desk is made up of various parts. Can you identify them? Make a list of the parts. Are these parts also things?*

2. *Is the classroom itself a thing? If not, what is it? (Remember the definition of a thing from Activity 1.)*

3. *If the classroom is a thing, is it at the same time also a part of a larger thing? If so, what is that larger thing?*

4. *Here are the names of some common things: a book, a cycle, the flu, a football team, Pythagoras's theorem, my family, a feeling of happiness at my birthday party. Each team will be assigned one of these. Make a list of all its parts, and all the parts of each part, and so on. Also, identify the larger thing of which it is a part, and further identify the larger thing of which that is itself a part, and so on.*

5. *Do you think that there can be a thing which does not have any parts? If you think there can be, give your reasons.*

6. *Do you think that there can be a thing which is not part of any larger thing? If you think there might be, give your reasons.*

# Activity 3. Knowing and understanding things

## Pre-requisites

Activities 1 and 2

## The concept in brief

When I have an experience of seeing an object, I can say 'I know that object'. This knowledge is first-hand knowledge. It is a fact. There is no reason to doubt that the object appeared to me. However, from that single experience I will not know what it is. In other words, I will not understand that thing. If, in a subsequent experience, I see this thing as a part of a larger thing, I will understand it. That is, I will come to know what its place and function is in the larger thing. I will come to know its purpose, which is to make that larger thing complete and functional. Or if, in a subsequent experience, this thing is seen as similar to a group of other things that we already understand, I will understand it. More generally, we can say that a thing is understandable when it is seen in context. A context is a larger thing of which the experienced thing is a part.

When I name a thing it means that it is similar in some way to some other things I have seen in the past; it is one of a group of similar objects. The similarity may be due to their form or to their function.

As an example, let us say I see a particular physical thing. I have no idea what it is or what purpose it may serve. I know it, but do not understand it. Then in a subsequent experience, I remember that I have seen similar objects before. In yet further experiences I compare the remembered objects with the one now seen. I say 'I am seeing a ball'. The second and third experiences are of thought things. This experience is of a memory, a thought thing. I now know what it is, but still do not know its purpose. In a still further experience, also a thought thing, I remember seeing a ball like this one on a cricket field being thrown about and hit with bats in a particular manner. I then say 'this is a cricket ball'. I see it as an essential part of a system of dynamic relationships among players, field and ball.

When I say 'I am looking at a cricket ball', it is a fact. But unlike the first experience of seeing the object, this fact is not beyond doubt. If I had ever seen a tennis match, but not a cricket match, I might have said 'this is a tennis ball'. But if I try to play tennis with this ball, well, it would not be much fun. We can call the original object a 'first-order fact'. We can then call the later objects 'second-order facts'. First-order facts are always indubitable, but not second-order facts. Or, we can say that first-order facts are certain, whereas our understanding of them is not. Whenever we use a second-order fact as a basis for action, we might make a mistake, or more generally, find that our action is inappropriate.

When I say 'I have understood' I am referring to a thought thing in which a given thing is seen in a context, as a part of a larger thing. But there is also the satisfaction of seeing it thus, and the satisfaction is an emotional thing. As a result of this, I am able to relate the thing to my own life, feel that it is a part of my life, and that I am part of the life of that thing and its context.

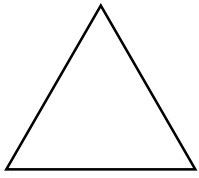
## Procedure

Have the members of your class answer these questions as teams. Ask one member of each team (not the same one as in the previous activity) to report his or her team's answers to the entire class. Compare and discuss these and try to arrive at a consensus on each answer.

In handling the discussion of the learners' answers to these questions it may be necessary to review the definitions of the terms given in Learner Handout 1.1, and you might introduce the definitions of first-order and second-order facts given in the 'Concept in brief' section to help students clarify and organise their thoughts.

## Questions

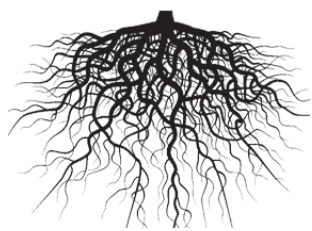
1. *What is this? What will you call it? Why?*



2. *What is this thing? What will you call it? Why?*

3. *What is this thing? Is it similar to the picture in Question 2? In what way? Does it have any purpose? What is its purpose?*

4. *What is this thing? What will you call it? Why? What is it a part of? Does it have any purpose? What? If it is removed from the thing it is part of, what will happen to that thing? Why?*



5. *This may look familiar, but what would you call it? Why? Are you sure?*

6. *What is this? What is it a part of? In case there is more than one answer to this question, which one best explains its purpose?*

# Activity 4. Physical things and space

## Pre-requisites

1. Activity 2

2. Geometrical concepts of lines, two- and three-dimensional figures, area, volume

## Concepts in brief

In Activity 1 we came to a general understanding of the concept of a physical thing. It is an object of which I become aware in my surroundings. It is distinct from every other physical object. To be distinct, it must enclose a volume of space (or an area of space in the case of two-dimensional objects). Furthermore, it must be separated from all other objects by an interval of space. The next, and crucial, question in this line of enquiry is: what is space?

Space is not a thing; it is an absence of things. It is what is outside physical objects. It is also what is inside them, to the extent that they are not entirely occupied by parts – that is, other objects. This may not seem to be a very satisfactory answer, but no one is known to have come up with a better one.

Some people have said that a physical object is composed of substance (or matter). But this is not an answer, for it begs another question: what is substance? Again, no one has come up with a definition of substance, or, no one has been able to say what substance is in itself. And so we are forced back onto our original answer: a physical object is an area or volume of enclosed space and it is distinct from all other objects because it is surrounded by empty space.

What we are saying is: if there were no things, there would be no space, or, at least we would not be aware of it. At the same time we are saying: if there was no space, there would be no things. We are defining each in terms of the other. We may overlook this, or forget it. However, neither space nor physical things is an independently existing entity. Together they offer us the only possible way of explaining how we experience physical things.

## Procedure

It is suggested that answering question 1 below be a team activity in the first instance. Allow the teams 15 minutes, or even 30 minutes, if necessary, to devise their answers. While they are at work, move around the classroom and visit each team to see what progress they are making. If a team seems unable to come up with an answer, you may help them along with a supplementary question such as: *What do you mean when you say 'there is space between my desk and that of my neighbour? Or, there is an empty space on that wall between the door and the window?* In the following whole-class discussion, ask one member of each team to present his or her team's answer to the class. Write each answer on the blackboard. Lead a discussion on these, comparing them, and attempt to come up with a single, agreed answer. Write this on the board as well.

Incidentally, visiting teams while they are at work will enable you observe individual students and evaluate them in terms of their ability to participate in group learning activities.

Questions 2 to 5 may be taken up for whole-class discussion and answering.

The first question in this activity is very general, and asked without any previous discussion. The objective of doing this is to get an idea what learners already understand before attempting to guide them in a process of concept development. In this way we avoid taking anything for granted and also do not needlessly spend time developing a concept the learner already grasps. We must begin from where the learner is.

## Questions

1. *What is space?*
2. *If there were no physical things, would you be aware of space?*
3. *Look carefully at some particular physical thing. Does it have a boundary? Does it occupy a definite area or volume?*
4. *What is outside the boundary of the thing you were looking at in question 3? What is inside?*

5. *A thing has, of course, other things inside it (parts of the thing). What is inside the parts? What is outside the parts, or in other words between the parts?*

6. *Now, look at the answers your team formulated to question 1, and that decided upon by the whole class. Would you now like to revise those answers? If so, in what way?*

# Activity 5. An experiment on things and space

## Pre-requisites

Activity 4

The concept of average and how to calculate it from a set of numbers.

## Concept in brief

In this activity children will learn how to conduct a scientific experiment, or in other words, they will learn how to generate new facts that will have a bearing on a particular prior assumption about the nature of phenomena. They will learn this by planning and conducting an experiment, interpreting the resulting observations, and finally drawing conclusions from them. In doing this they will also acquire the concept that the work of generating new and relevant facts must follow a definite procedure, in a series of definite logical steps.

The concept of things and space developed in Activity 4 is that things, and parts of things, are demarcated one from another by intervals of unoccupied space between them. Since all things are presumed to have parts, it therefore follows that all things have some unoccupied space inside them. Is there any evidence (facts) to support this conclusion? Can we devise an experiment, that is, a series of specific actions, which will provide such evidence? These are the questions that will be posed to the members of your class.

The general format for conducting a scientific experiment is as follows.

1. State the assumption to be tested and justify it.
2. Plan the experiment and justify its design.
3. State what results are expected.
4. Conduct the experiment according to the plan and record the results.
5. Draw a conclusion from the experimental observations. Do the experimental observations support the assumption that the experiment was designed to test? How? Do they not support the assumption? Why?

6. Visualise another experiment that might be done to test the assumption further.

All these are to be neatly and systematically written down by the learners in their worksheets. This is an essential part of scientific enquiry.

It is suggested that you refer back to definitions of the terms 'fact' and 'assumption' given in Learner Handout 1.1, and to remind the children of them.

## Procedure

The format in the previous section will help you guide children in conducting this activity. The format is not to be told to them beforehand; it will emerge in the course of the activity itself.

The questions and the experiment that make up this activity are to be taken up by teams in the first instance. After teams formulate their answers to each question, compare them in a whole-class discussion, and create a consensus on each answer. Write the experimental results of each team on the blackboard and compare them. The results may be expected to vary somewhat. Ask the learners why this is so. Also ask them to calculate the average value for the results.

## Requirements

To perform their experiment, each team will need a glass beaker (1-litre), a measuring cylinder (500-ml), sugar, ordinary, clean water, and a glass rod (25-cm long).

## Questions

The questions for this activity are quite long. They are therefore being given in a Learner Handout (5.1). Distribute this to the children, and before taking up each of them ask one child to read it out loud to the class and be sure everyone has understood it.

In questions 2 and 3 a hint has been given of a relatively simple experiment that might be done. If the students are still unable to formulate a definite experiment on their own, you might ask them what happens when one puts a spoonful of sugar in a glass of water.

## Learner Handout 5.1

# Questions

1. *In Activity 4 we concluded that it is possible to experience physical things (that is, see and feel them) because they are surrounded by empty space. We defined empty space as a place where there are no physical things. If this is true then there must be empty space within physical things that separates the parts of that thing one from another. If there was no empty space, we would not be aware of the parts. We also agreed that even very small things must have parts, even if we cannot see or feel them. Why did we say this? Write you answer neatly in your worksheet.*
2. *This means that things like a glass of water or a crystal of sugar must have parts, even though we cannot see or feel them. Do you agree? Why? Write you answer in your worksheet.*
3. *Maybe you do not agree with the conclusion that all things have parts. Maybe you say, 'I don't believe that anything exists if I cannot see it or feel it. OK. Let us say that you may be right. Is there any way that we could prove that a beaker of water or a crystal of sugar, for example, have parts? How? Write your answers to these questions in your worksheet.*
4. *If you have thought of a way to prove that things have parts, make a detailed plan for carrying it out. Write your plan in your worksheet.*
5. *Carry out your plan carefully and write down the results in you worksheet. When you carry out your plan, you are said to be conducting an experiment.*
6. *Does the result of your experiment support your assumption that things have parts? How? Explain your reasoning in writing in your worksheet.*
7. *Can your conclusion be assumed to apply to all physical things? Can you be sure that that there may not be something that does not have parts? Write down your answers in your worksheet.*

# Activity 6. The forms of things

## Pre-requisite

Activity 4

## Concept in brief

In Activity 4 we defined a physical thing as an enclosed space, and space as that which is thus enclosed. In this activity we will pursue this line of thought further and ask ourselves; how do we distinguish one thing from another thing, say a sphere from a cube, or a triangle from a square? In what way are they different? Clearly, the space itself that is enclosed in a sphere and that which is enclosed in a cube is indistinguishable. Therefore, what distinguishes the two is their differing forms, that is, their spherical and cubical shapes. In all our further thinking and discussion about physical things we will be thinking and talking about forms only.

There are a variety of experiences for which I can find, or construct, a common context. Let us suppose that I see a physical thing of which I later say 'it was a mango'. I can also refer the experience of touching a particular thing with my fingers (without seeing it) to the context 'a mango'. Similarly for the other experiences of a particular taste or smell (again, when my eyes are closed). In everyday language I say 'a mango is that thing which looks, feels to my touch, tastes and smells like these experiences of mine.' Further, I say 'a mango' has these properties, or characteristics. When I make these statements I am referring to the 'form' of mango.

It helps to keep in mind that a mango is a common context for a number of prior experiences of various kinds; in other words, it is a thought thing. My world is made up entirely of thought things. For convenience I may think and act as if a mango is an actual entity in the world which I experience.

Our definition of form is thus: 'that which distinguishes one type of thing from another'.

## Procedure

This activity will probably be most effective if carried out on a team-work basis in the way suggested for Activity 4. It may be necessary to remind learners of the four kinds of experiences (Activity 1) when they attempt to answer question 5. Distribute Learner Handout 6.1 after completing the questions. Devote one class period to discussing it after the children have read it.

## Questions

1. *What do you mean when you say 'I am looking at a stone?' Why do you say it is a stone?*
2. *Suppose your eyes are closed. A friend says 'I have brought you something' but does not say what it is. Then you become aware of a particular smell and you say 'you have brought me a mango'. Why do you say that?*
3. *Again, suppose your eyes are closed and your nose also. Your friend says 'I have brought you something to eat' and puts a piece of it in your mouth. You become aware of a particular taste and say 'this is mango'. Why do you say that?*
4. *It seems that there is a variety of experiences that you refer to as 'mango'. What then is a mango?*
5. *What kind of thing is a mango?*
6. *Why do you not say 'this thing is an apple'?*
7. *What would you call that which defines a physical thing, and distinguishes one thing from another?*

## Learner Handout 6.1

# Small things we cannot see or feel

Recall that in Activity 5 we concluded that two physical things, both of which we can see and feel, are actually composed of smaller parts which we cannot see or feel. From other experiments, scientists have concluded that all physical things consist of such small parts. And further, that some of these smaller parts are also made up of yet smaller parts. Air, for example has been found to be composed of a mixture of several different types (that is, forms) of particles; the most numerous of these are hydrogen, oxygen and carbon dioxide. Iron, on the other hand, has been found to contain only one type of parts, and all the parts are the same type as the visible chunks of iron themselves. Such things are termed elements. Carbon dioxide, however, has been found to contain two types of particles, carbon and oxygen. It is therefore a compound thing. Carbon and oxygen are both elements. In later exercises we will encounter many compounds and elements.

There is evidence that even small particles of elements also have parts, but what the forms of these might be is uncertain.

### Some definitions to remember:

In an **element** the small parts of a particular type of thing all have the same form as the thing itself.

In a **compound** the small parts of a particular type of thing have more than one form, and those forms are all different from the form of the thing itself.

# Activity 7. Systems of things

## Pre-requisites

Activities 2, 3 and 6

## Concept in brief

Everything is a system of parts. The parts are inter-related, each having a definite place and function in creating and maintaining the form of the whole thing. Thus a plant is a system of organs, each of which contributes to the structure of the plant in a unique way. A family is a system of individual people related to each other physically, mentally and emotionally. A worldview is a system of basic concepts. Flu is a system of feeling or sensation of things (fever, sore throat, runny nose, loss of appetite). Everything that exists is thus related to every other thing in the system in which it participates; nothing exists in isolation.

All things are living beings. All children know this intuitively. People of all cultures and ages before the advent of the European Enlightenment worldview in the 17th century also understood the behaviour of things in this way and acted accordingly.

When we say that a thing is a living being we mean that it is sentient, intelligent and active. It cognises the presence of all the other parts of the system in which it participates and their positions in relation to itself. It also intuitively understands its place in the system, and, finally, it endeavours to remain always in its proper place in the system.

All systems share three characteristics. The first is that they are self-limiting, self-organising and self-maintaining. A number of things spontaneously organise themselves into a system, drawing a line (or boundary) around themselves to create a distinct entity. Once formed, the system resists or neutralises any influence that can disturb its structure.

Second, they are dynamic, not static entities. Within a system, the parts are continually moving, changing their positions in relation to the other parts. They may move slowly or rapidly, travel long distances or short. However, their movements are ordered by the requirements of the pattern of the system. The pattern of their movements is a feature of the form of the system. A good analogy, suggested by the educationist David Selby, is that of people dancing. The dancing may be done by couples, by groups, or even by individuals. An individual may dance in place. In whatever ways they dance, however, the movements of each of the dancers knows his or her place in the pattern of the system, and he or she endeavours to remain in that place.

Third, systems are born and they die. A system dies when it stops functioning as an ordered whole. Its form disappears, never to reappear. The parts may not die at the same time, but go their own ways. They may be taken up by and participate in a new system later. Some systems live for a very long, while others live very briefly. They grow and mature, then degenerate and die. Their birth is marked by the experience 'I am this thing (system)'. A new form appears that never appeared before. This is followed by a long series of appearances of similar things, and their death is marked by a cessation of those appearances. A mountain and a star live for a long time, a housefly and a bacterium for a very short time. A system may be killed if a part is forcibly removed, or if a foreign part is forcibly introduced, or if its structure is distorted by pressure from outside. If a part of a system dies pre-maturely, the entire system may die.

The foregoing description of systems characteristics is for systems of physical things. The same characteristics are, however, also shared by other types of things: with systems of thoughts, emotions and feelings the terms 'relative', 'relative movement' and relative position' are all to be understood metaphorically.

## Procedure

The intention in this activity is to help learners develop further concepts about the nature of things from their own experience. You will probably have to introduce hints, suggestions and information from time to time to sustain the discussion and bring it to a successful conclusion. You will be guiding them to a definition of a thing as a system, that systems can be disabled by removing a part or adding an alien

part, and finally that all systems are born, live and then die. Keep in mind that these concepts are crucial in the talking about and practising alternative systems of farming, health care, manufacturing and education. In fact, these concepts are implied in these fields and understood intuitively by those involved in them. However, it is necessary for practitioners to articulate these in order to ensure consistent and effective action.

Developing a definition of a system (Question 1) can be a whole-class activity. For Questions 2 to 5 team work followed by whole class discussions is recommended. Ensure that learners write all answers and conclusions in their worksheets. After completing Questions 2 to 5 give children Learner Handout 7.1 and after they have read it devote one class period to discussing it. Distribute Learner Handout 7.2 and ask the children to read it. Thereafter devote a class period to discussing it.

## Questions

1. *What is a system? Look up the meaning in your dictionary if you are unsure how to define it. Share your answer with the class when asked to do so by your teacher.*
2. *Amrita said, 'I feel that trees and animals are alive, and that that mountain and this stone are alive. When all the trees are cut from the mountain, I feel pained; it is as if my own skin were peeled off. And when I want to be alone to think calmly about events in my life, I go and sit next to friend stone.' Do you have feelings like these? Describe them to your team mates.*
3. *A person is a living system, and each of its parts are living things. If a person's leg is removed, what will happen to him or her? If his or her heart is removed what will happen? If a cobra bites a person what will happen to him or her?*
4. *Imagine a plant. It grows, produces flowers and seeds and then turns brown and dry. Eventually it falls to the ground and slowly disintegrates. What will you say has happened to the plant? What do you mean?*
5. *Would you say the same thing about a crystal of sugar when it dissolves in water? Why? Why not? From your answers to this question and Question 4 can you draw any general conclusion that would apply to all things? If so what is it? Be sure to write your answers to these questions and also those to all the previous questions in your worksheet.*

## Learner Handout 7.1

# Dancing particles

All things are living. This means that they can move by themselves. In fact, they are always moving. They may move from place to place, or they may stay at one place and only move back and forth at that place. For example, during sports period, the children are all moving around the playing field, but during maths class they are all sitting at their desks. However, even during the maths period the students move in their seats; they move their hands and arms, shift position in their seats and maybe even quietly tap their feet on the floor under their desks. Even in a stone the small particles are not completely inactive.

When we want to understand a system we often describe it in terms of a metaphor. (Look up the meaning of this word in your dictionary and write it down in your worksheet.) The metaphor we will use is that of dancing. We will say that a system is a group of dancing parts. The individual parts may dance individually, or in pairs or in small groups. They may dance in place, or they may dance around the whole dance floor. But however they dance, they do so to the rhythm of the music that is playing.

Thus in a solid thing, like a crystal of sugar or a steel spoon, the particles do not move from place to place, but they do move individually, each in its own place like an individual on the dance floor who simply taps his or her feet or sways to the rhythm of the music. In a liquid thing like a glass of water the particles dance in groups of three (two hydrogen particles and one oxygen particle) and move both within their threesome and all around the glass. In a gaseous system like hydrogen in a closed flask, the particles dance at a very fast pace, moving rapidly all around the flask.

In any given system, there is only one tune being played, one rhythm that determines how the particles dance. And all the particles dance according to this rhythm. The particular rhythm of the system is what determines it form. The combined movements of all the particles dancing according to the given rhythm make a definite pattern.

Now consider what happens when two systems are merged, as when you dissolved sugar in water (Activity 10), or when hydrogen and oxygen react. In each system the particles are dancing according to the rhythm of that system. When the two systems merge, all the particles of both systems begin to dance according to an entirely new rhythm, creating an entirely different pattern of movements. When the rhythms of the original systems cease, the particles of both the systems lose their previous identity, and gain a new common identity. Thus, hydrogen and oxygen particles cease to exist after the reaction; together they become water particles. Similarly, water particles and sugar particles cease to exist; they can no longer be identified as water particles or sugar particles. Together they all become sweet water particles.

## Learner Handout 7.2

# Systems health

The concept of systems health is very helpful in understanding all types of systems. A healthy system is one in which all the parts are present, each one is in its proper place and all are performing their proper functions. For example: the element iron is necessary in the proper functioning of the human body. If it is present in lesser amount than is required, a person becomes unhealthy. This sickness is called anaemia. The person feels tired and weak and sometimes out of breath. The person cannot lead a normal life.

Try to visualise this in terms of the dance metaphor. Iron particles join several other elements to form a compound called haemoglobin. This haemoglobin is a part of the blood. Within each haemoglobin compound thing, the various elements are a dance team. But if there are not enough iron particles to form the required number of teams, the blood system cannot dance properly, and this disturbs the dancing of the next larger system, the whole body of the person.

A system can also become unhealthy if some element or compound enters a system of which it is not naturally a part. Thus when a mosquito bites us, the area around the bite becomes swollen and red and also itches. How are we to understand this? The mosquito injects a compound that is not naturally found in the human body. Using the dance metaphor we say that the mosquito compound is an odd and unwelcome dancer. He disturbs the other dancers and the whole dance (swelling and itching) because he does not know the dance they are dancing. Eventually, the other dancers throw him out and the dance continues as before – and the swelling goes and the itching stops.

If a cobra bites a person, it injects a stronger foreign compound and this disturbs not just the local dance but the dance of the entire body system. In fact, the disruption is so great that the dance of the body system comes to a halt; in other words, the person dies. Similarly, if we eat spoiled food or drink dirty water or breathe polluted air, we become sick and can even die. The spoiled food, dirty water and polluted air all contain elements and compounds that are not parts of the human body system and which disturb its dance.

Other types of systems react similarly to the loss of one of their parts and to the injection of a foreign part. We will encounter many examples of this later on. To give you a brief preview: if we think of a village as a system of things like trees, crops, animals and people, the cutting down of all the trees will make the system sick. If the village system is sick the crops, animals and people all become sick. If we think of our class as a system, then if Sujata and Amit do not come to school one day, the work of their teams will be affected, and thus the learning process of the whole class. If Mr. Nauriyal, our teacher, does not come, then too the working of the class will be disturbed. We may have fun for a while, but quickly realise that we are not learning anything important. The class got sick that day. Once some visitors brought rabbits to a small island where there were no rabbits previously and also no animal that eats rabbits. As a result the rabbits multiplied and ate up all the plants on the island. They all died of starvation and all the other animals and insects that lived on the vegetation also died. We can say that the whole island system died.

# Activity 8. Time and motion

## Pre-requisites

Activity 7

Ability to plot a graph of the changing relationship of two variables.

## Concept in brief

The concept of time, like that of space, is essential for an understanding of physical phenomena. And, like the concept of space, it depends for its definition on our definition of physical things. When we say that a thing 'moves', we require concepts of both space and time.

Physical things, like all kinds of things, are momentary appearances (Activity 1). When we say 'time has passed' we refer to the memory (a thought thing) that one thing appeared, it disappeared and another thing appeared. In the absence of things appearing and disappearing there would, as far as we know, be no time. Without time there would be no things of any kind, or at most only one thing.

Physical things are constantly moving (Activity 7). When we say that a physical thing moves we mean that in two consecutive experiences a similar thing appeared, but in a different spatial relationship to some other thing that appeared with it in both experiences. In other words, one part of a thing changes its spatial position in relation to the other parts in successive experiences. Thus when we see a meteorite moving in the night sky we say it moving because in each of a series of appearances it is closer to the horizon. Or take the example of a cricket ball. I am batting and I have just hit a *chakka*. I watch the ball. It soars up, arches slowly and then falls into the stands. In other words, its spatial relationships change in successive appearances in respect of me, the playing field, the stands and to a cloud in the sky. It also becomes smaller in each successive appearance, or in other words, its spatial dimension (diameter) shrinks relative to those of the stadium. By way of summarising this

sequence of appearances we simply say 'the ball moved from my bat to the distant stands'.

The basic unit of time is the interval between the appearance of one thing and that of the next thing. Since this interval is very small it is more convenient to take as a unit a group of several such intervals. For example, the sun's position relative to the horizon changes moment to moment, but this change is too small to be perceptible. We know from experience (a thought thing) that the sun moves from a particular point on the horizon in relation to where I am standing to the same point the next morning. We take this interval as a standard unit of time – a day. This interval is divided into smaller and smaller equal intervals – hours, minutes and seconds. We use these units in everyday life, as when we say 'A class period is 40 minutes long', or 'the train journey took 10 hours'.

## Procedure

The questions are to be answered by groups working independently, followed by whole class discussion after each one in the usual way. If you find that learners are having trouble with Question 1, here are two supplementary questions you might put to them at the time you visit their group.

a) I arrived at school after you did, but before Suresh. What does this mean?

b) In Activity 1 we defined a thing as a momentary appearance. What does this mean?

Or you can frame other questions or hints that may help them. After finishing all three questions give them Learner Handout 8.1, and after they have read it spend one period on a whole-class discussion

## Questions

1. *What is time?*

2. *Can we say that if there were no things of any kind there would be no time?*

3. *How do I come to know that a physical thing has moved? What does it mean to say that a particular physical thing moved? Here is a hint: suppose I hit a cricket ball with a bat. How do I know that something happened to the ball?*

## Learner Handout 8.1

# Units of time

In order to organise our activities it is necessary to divide time into units, and these units should be the same for everyone, everywhere. For example, the hockey coach says to all the players: 'we will meet on the playing field after one hour'. By saying this he or she expects that all the players will come to the playing field at the same time and practice can begin.

The basic unit of time is the interval between the appearance of one thing and the appearance of the following thing. This interval is very small, only as long as the 'wink of an eye', and hence not very useful. A larger unit composed of a definite number of these small intervals is needed. One convenient unit is the first appearance of the sun as it rises above the horizon on two successive occasions. This is termed a 'day'. This day is divided into 24 equal units, termed 'hours'. Each hour is divided into 60 'minutes' and each minute is divided into 60 'seconds'. Everyone accepts these units - and so, we all reach school in time for assembly every morning. Similarly, everyone who wants to take the train to Kathgodam reaches the station before 20:45 o'clock when the train is scheduled to leave.

# Activity 9. Weight, force and work

**Pre-requisites**

Activities 7 and 8

A working knowledge of the metric system of weights and measures.

**The concepts in brief**

For everyday life and for our work two important concepts are helpful. From experience we all know that physical things have weight and that to lift them up requires effort. We say a thing is weighty because it falls to the ground if we lift it up and then release it. When we lift it up we realise that the amount of effort, or force, required to do so is proportional to its weight. People have always wondered why things are weighty. An answer to this question follows logically when we have understood the concepts of things and systems of things.

We have seen that all things are parts of one or another system. To say that a thing is part of system means that it participates actively in the system; it knows its place in the system and actively endeavours to remain in that place. If, for any reason, it gets moved from its proper place it tries to return to it. A proper place for a stone, for example, is the surface of the Earth; it is part of the Earth system. If we lift it up, it will, given the opportunity, return to the surface of the Earth. Its opportunity is when we release it. If we had not lifted it up it would have had no need to return. In other words, it only has weight when we lift it up – otherwise not.

This concept needs to be further elaborated. Each part of a thing has weight. A basket of oranges has weight, and so does every individual orange. The weight of the basket of oranges is the sum of the weights of all the individual oranges (plus that of the basket). Thus the basket of oranges weighs more than any one of the oranges.

A thing that is moving in order to return to its proper place requires a force to stop it. A calf separated from its mother will run to her when it sees her. The calf's proper place is with its mother. To stop the running calf requires force. And the force required is proportional to the calf's size, and hence its weight. This is also true when we remove the calf from its mother.

When we have lifted a stone or stopped a running calf we have exerted a force over a period of time. The product of weight x time is termed 'work'.

**Procedure**

The following questions are intended to help students formulate the concepts of weight, force and work. They may be taken up as team work and then followed up by whole-class discussions. If necessary you may help the students with Question 8 by asking them the following supplementary questions.

1. Do all physical things have weight?
2. Why are some things heavier than others?
3. Why do we feel tired when we have to carry a bundle of grass for a long distance or take a calf away from its mother?
4. Why do you feel more tired from carrying 10 bricks than from carrying one or stopping a big calf than from stopping a small one?

**Questions**

1. *You are helping your father build a wall. You lift a stone and place it on the top of the wall so that it can be fixed in position. You say 'this stone is heavy'. What do you mean?*
2. *Are all physical things heavy? Why? (Keep in mind that the stone is a living thing; this thought may help you to answer this question.)*
3. *Imagine that you have three bricks and that you weigh them on a two-pan balance. Let us assume that they are all exactly the same. First place one brick in each pan. What happens? Now place two*

*bricks in one pan and one in the other. What happens? Is what happens different from what happens when you place one brick in each pan? How?*

4. *Take two coconuts, a big one and a small one. Place one in each pan of the balance. What happens? Why? Is your result with the coconuts related in some way to your results with the bricks? How?*

5. *Suppose you have to bring stones from 500 metres from the quarry to the wall you are helping your father to build. Half way, you say to yourself: this stone is heavy and the distance is great. I wish the quarry was nearer to the wall we are building. Why do you say this?*

6. *One of your calves somehow gets out of the calf enclosure and runs towards its mother. However, it is not milking time and so you catch hold of the calf and try to stop it. Is the effort to stop the calf related to the effort you would have to make to lift the calf off the ground? How?*

7. *Or, suppose the calf has already reached its mother when you notice it. You then pull the calf away from its mother and take it back to the calf pen. Is the effort to take the calf back to its pen related to the effort you have to make to stop the running calf? How?*

8. *Can you make a few general statements about all physical things from the answers to the previous questions? In other words, can you make a general statement about all physical things, both when they are stationary and you are trying to move (or lift) them and when they are moving and you try to stop them?*

# Activity 10. From one thing to another

## Pre-requisites

Activities 7 and 9

## Concept in brief

The concept of 'change' is used routinely to explain phenomena. Thus we say that, as it grows, a tomato plant changes from a small, immature plant into a mature one, or that a chick, as it grows up, changes into a hen. The tomato plant seems to be the same today as it was yesterday, only a little bigger, and maybe with a few yellow flowers. The chick seems to be the same chick it was yesterday, except that today we notice a few small feathers that were not there yesterday. In another instance we say that a caterpillar 'changed' into a butterfly, or that a mixture of hydrogen and oxygen, under suitable conditions, 'changes' into water. The caterpillar and the butterfly, however, are utterly different, and so are the hydrogen and oxygen, on the one hand, and the water, on the other. What, then, do we mean when we say one thing has changed into another thing? Is this a valid concept? Does it really explain anything? The purpose of this activity is to try to answer these questions.

In attempting to answer these questions two lines of reasoning may be followed. Both begin with the basic assumptions of the living systems worldview, and end with the conclusion that the term 'change' is untenable. The first is to argue that things are momentary appearances, as brief as the 'wink of an eye' (Activity 1). Thus what seem to be relatively enduring things are actually series of similar things succeeding each other rapidly, each similar, though not identical, to the one preceding it. In other words, one thing does not change into another, it is succeeded by another.

The second line of reasoning is as follows. When we say that A changes into B we are implying that something about A and B is the

same, while something else is different. It is obvious that what is different is the forms of A and B. What then is the same? We only become aware of a thing because it has a form (Activity 4). In the absence of form, we cannot say that two things are the same (or different), or, indeed, that there even are two things. Thus there is nothing about A and B that is the same, and hence the very concept of change is untenable.

Yet there are regularities in the ways in which one thing is succeeded by another. Thus the appearance of an oak tree is not usually immediately succeeded by the appearance of a tomato plant. A particular type of caterpillar is always, in our experience, followed by the appearance of a particular type of butterfly. A mixture of hydrogen and oxygen, in a suitably arranged experiment, always give way to the appearance of water. Putting sugar in water is always followed the appearance of sweet-tasting water.

Moreover, the weight of hydrogen particles plus the weight of oxygen particles always equals the weight of the succeeding water particles. (When 1 g. of hydrogen and 8 g. of oxygen disappear, 9 g. of water always appear.) This suggests that the total number of particles of the hydrogen plus those of the oxygen is the same as the number of particles in the water. However, the particles in the water are not the same as those in the hydrogen and oxygen. Their forms are different. Instead of 'change' we must think in terms of 'regularities'.

## Procedure

This activity is composed of three sub-activities. In each sub-activity a question is posed which the students will attempt to answer. The three questions are given in Learner Handout 10.1. Begin by giving all the students this handout. Divide the teams into three groups and assign one of the questions to each group. Allow sufficient time for the teams to work on their answers, visiting each team now and then to assess their progress and, if necessary, offer hints or suggestions. When they have finished, ask each team having the same question to present its answer to the entire class, and follow this up with a general class discussion. Repeat this for the other two questions. Finally, attempt to formulate a definite answer to the question: do things change?

## Learner Handout 10.1

# Do things change?

1. Two months ago Sujata saw a small tomato plant, barely 5 cm tall. Today she is looking at the same plant and it is 50 cm tall, and it has more leaves than before and also some yellow flowers. Is it really the same plant she saw three months ago? How can it be the same plant when it looks different in many ways? What do you think?

2. One day Mohan saw a caterpillar on the underside of a tree leaf. It was spinning a cocoon around itself. Thereafter he looked at the cocoon every day. One day he saw that it had split open and an insect was coming out of it. It was wet, but as it dried out it spread its wings and he saw that it was a beautiful butterfly. When he told his team mates about this he said 'the caterpillar changed into a butterfly'. Was he right to describe what he saw in this way? What does it mean to say 'the caterpillar changed into a butterfly'? What do you think?

3. Mumtaz was doing an experiment in the laboratory. She found that, under suitable conditions, a mixture of 1 g. of hydrogen and 8 g. of oxygen suddenly turned into 9 g. of water. She wondered how to describe her results. Should she say, 'hydrogen and oxygen react with each other to form water'? Then she had a doubt. She realised that this statement implied that she thought that the original particles of hydrogen and oxygen somehow continued to exist in the water. What do you think about this?

# Activity 11. Temperature and heat

## Pre-requisites

Activities 7 and 10

## Concepts in brief

Suppose there are two beakers of water. The water in one was taken from the fridge and in the other the water had been placed on the stove. We dip a finger into one and say 'it is cold' and into the other and say 'it is hot'. These two experiences are sensation or feeling things.

The flame of the stove is very hot. If we place a beaker of water on the stove it becomes hot. And it seems that some of this hotness of the flame is transferred to the water, making it hot. The inside of a fridge is cold, and if we place a beaker of water in it, the water becomes less hot. It seems that some of its hotness is taken away from it by the fridge. This idea is strengthened when we notice that the coils at the back of the fridge are very hot and the air near the coils is hotter than the air farther away. It seems that the hotness taken from the water is transferred to the air.

What is this 'hotness'? When we say it is transferred from one physical thing to another, we are suggesting that it is a physical thing. But it is not. It is merely a comparison of feeling things – now this physical thing is hot, and earlier it was cold – which is a thought thing. Still, for convenience, it is taken to be a physical thing. It is termed 'heat'. A metaphor is useful here; heat is like a fluid that flows from here to there.

The first concept to be developed in this activity is thus the concept of heat as outlined above. The second concept to be developed is that in gaining or losing heat a physical thing expands and contracts. The most striking example of this is the mercury in a laboratory thermometer.

When a physical thing expands on being heated we can only conclude that the particles of the thing move further away from one another, leaving more empty space between them. Why do they do this? Let us answer this in terms of the dancing particles metaphor. When a thing becomes hotter, the tempo of the music being played increases, the rhythm remaining the same. The dancers spin more rapidly and their circular movements become larger as they move faster. To avoid colliding with one another they move farther apart. As the thing cools, they slow down and move closer together.

The third concept to be developed is that of pressure. If a gas is confined, say in a sealed flask, and heated, the particles move faster and they try to move farther apart. Using our dancing metaphor again, we can imagine what happens when they try to move further apart. Those near the walls of the flask will bump into the walls and bounce back since the walls cannot be moved outwards. The combined effect of all the particles banging against the walls of the flask is termed 'pressure'. In other words, the particles collectively exert a force against the walls of the flack as they try to go to their natural places, that is, their places in the dance. (See Activity 9 to review the concept of force.)

The pressure of a gas also increases if the volume of its (sealed) container is reduced. Thus in the cycle tyre pump, when the handle is depressed the pressure of the air inside increases. This pressure is transferred to the tube as some of the air particles dance out of the pump into the tube. With more particles in the tube, it inflates – at least to the limit permitted by the tyre. After that, when more air from the pump enters the tube, its pressure increases.

**Procedure**

The questions that follow are to be taken up as group work. Before asking Question 2 ask each group to heat some water on a Bunsen burner in a beaker and take its temperature before and after heating for some time. Ask them to write their observations in their worksheets. After completing all the questions, distribute Learner Handout 11.1 to

the learners. After they have studied it on their own or in teams, devote a class period to discussing it. Here is a hint you could give them, if necessary, to answer the question at the end of the handout: what happens when we strike or rub two physical things together?

**Requirements**

One laboratory thermometer, two glass beakers, one Bunsen burner and one asbestos pad (to place under the beaker) for each team.

**Questions**

1. *Meera placed a katori of cold water on the stove and lighted the burner under it. After a few minutes she put her finger in the water and said 'the water is now warm'. Still later she again put her finger in the water and said 'now the water is hot'. John said 'yes, the water is getting heated up by placing it on the stove. Some of the heat of the flame of the stove is being transferred to the water'. Kuldeep asked the others, 'but what is heat'? All the team members became quiet, trying to think of the answer to this question. Mr. Nair, their teacher, saw that they were having trouble answering this question. He asked them: 'what type of thing is heat? Is it a physical thing, that is, does it occupy space? If not a physical thing, what type of thing is it?' Now they began to think about these new questions, and after some time they told Mr. Nair 'we now have the answer to our original question - what is heat.' He said 'good. Now share your answer with the whole class. We will all discuss it.' What is your team's answer? (Here is a hint: sometimes in order to understand something we invent a metaphor.)*

2. *In measuring the temperature of water in a beaker you noted that the height of the column of mercury in the thermometer increased as the water got hotter. Why do you think this happened?*

3. *When a gas in a flask with a rubber stopper closing its mouth is heated, the stopper may pop out if it is not firmly in place. Can you explain why it pops out?*

## Learner Handout 11.1

# Heat and Light

When one thing, or set of things, let us say A, disappears and another thing or set of things, call it B, appears, and when B repeatedly follows A, we refer to it as a 'process'. In other words, all regularities in phenomena are processes. (If you are not familiar with the word 'phenomena' look it up in your dictionary.)

Combustion is a process in which a mixture of oxygen particles and those of another element disappear, and particles of other elements or compounds appear. Thus magnesium and oxygen particles disappear and particles of magnesium oxide appear. This process is referred to in the following manner.

oxygen + magnesium $\longrightarrow$ magnesium oxide

The word 'oxide' is derived from 'oxygen' and signifies that this process began with the disappearance of oxygen.

Another example of combustion is when oxygen particles and those of carbon compounds (like wood, coal and sugar) disappear and carbon dioxide and water particles appear. This is represented as:

Oxygen + carbon compound $\longrightarrow$ carbon dioxide + water

In the case of some carbon compounds, like wood and coal, some smoke and ash are also produced because in addition to carbon compounds they also contain other compounds like those of silica, phosphorus and sodium.

Yet another example of combustion is the process in which two particles of hydrogen disappear and one particle of helium appears. This occurs

in the sun which is composed of hydrogen particles which are slowly disappearing and while helium particles are appearing.

What is common to all types of combustion is that heat also appears. And in all cases heat also disappears at the beginning of the process, though it is much less than the heat which appears at the end of the process. Thus to start the process of burning wood, we must apply a little heat to it; this we do with something that is already burning.

In some processes, heat disappears at the beginning, but no heat appears at the end. An example of this is when carbon dioxide and water disappear and sugar appears in the leaves of plants when the sun shines on them.

In all processes of combustion, whenever heat appears or disappears it is accompanied by light. What is light? Like heat, we know the experience of light, but we have trouble defining it. And as with heat, we finally use a metaphor to describe and explain it. For heat, we decided on the metaphor of a liquid thing that flows from place to place. For light we will say that it is a solid thing. Thus we can visualise small particles of light moving from a hot, bright thing (a thing undergoing combustion) to other dark, non-burning things. When light particles reach a cold dark thing it becomes bright and hot, or at least warmer. The particles of light travel in straight lines. Moreover, when the particles of light collide with a physical thing, they bounce back again and travel to other things.

A few processes take up light (as well as heat) at the beginning but no light (or heat) is produced at the end. Here again the process in the leaves of plants, referred to a moment ago, is an example.

**Question:** Aside from combustion, can you think of any action or process in which heat and light are produced? How does it happen?

# Activity 12. Electricity and magnetism

## Prerequisites

Activities 7 and 11

## Concepts in brief

Electricity, like heat and light is a thought thing that is used to explain the relationship between two physical things. As for heat and light, we also say it 'flows' from one thing to another. In the case of electricity, however, it flows from thing 'A', say, through a metal wire and ultimately returns to the same thing 'A'. On its journey along the wire it can produce various distinctive phenomena. Thus, if the wire is very thin, it will heat up and even emit light. The flow of electricity in a wire can cause a piece of metal placed near the wire to move.

For convenience, it is usual to think of electricity as a stream of small physical particles, small parts of the physical thing 'A' that is the origin of the flow of electricity. These small parts get detached from the thing which creates it when the thing is rubbed against another physical thing. The displaced parts are not allowed to return immediately to the thing, but are forced to flow though a wire in order to return. The particles flow because, once they are detached from their proper place in the thing, they try to return to it. Particles can also get detached from compounds during certain chemical reactions and made to flow through a wire to return to the site of the chemical reaction.

The naturally-occurring mineral magnetite consists of iron oxide, a compound of iron and oxygen. It attracts other pieces of magnetite and also pieces of elemental iron. This property of magnetite is termed magnetism. The piece of magnetite mineral is termed a 'magnet'. If a piece of magnetite is suspended by a string it will always align itself with the North-South line of the Earth. Moreover, the same point on the piece of magnetite will always point towards the North. In other words, it has a North-pointing side and a South-pointing side. The earth itself

is a magnet because it contains a large amount of magnetite. Pieces of magnetite, when detached from the main body of the Earth, still maintain the North-South orientation of the Earth if it is permitted to do so. This phenomenon is one aspect of the whole Earth system in which each part knows its orientation in relation to the whole and moves to conform to that orientation.

Electricity and magnetism are related phenomena. Wherever an electric current is flowing near a non-magnetic metal object, that object becomes a magnet. It is called an electro-magnet to distinguish it from a naturally-occurring magnet. Scientists suggest that the small particles of electricity flowing through the object are themselves small magnets, each having a North facing side (designated by the sign '+') and a South-facing side (designated by the sign '-'). All particles of electricity, though flowing, maintain their North-South orientation in relation to the Earth system, and all together give the entire object the same North-South orientation.

**Requirements**

Each team should be given the following:

1. a torch battery
2. two lengths of insulated wire (each about 25 cm long) with about 2 cm of wire exposed at either end;
3. one piece of insulated wire 75 cm in length with 2 cm of wire exposed at either end;
4. a torch bulb;
5. a roll of black electrical tape;
6. a small bar magnet;
7. One iron nail (10-12 cm in length); and,
8. Half a dozen straight pins.

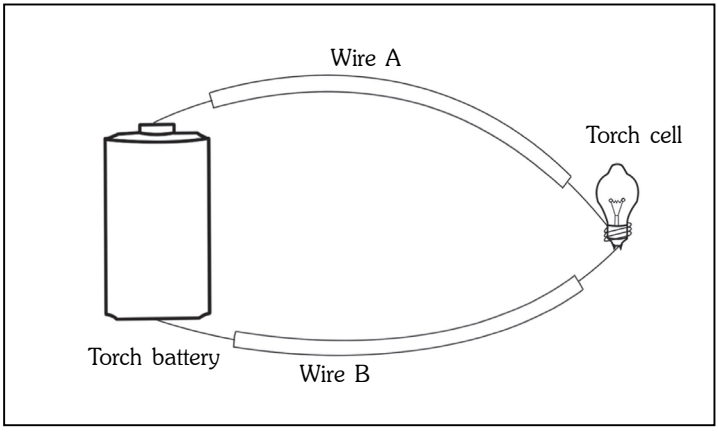
**Procedure**

Each team will carry out the following sub-activities 12a, 12b and 12c and answer the accompanying questions. It may be necessary to

give them a few hints when you visit the teams. For this you can draw on the write-up in the 'Concepts in brief' such as that the particles of electricity are like small magnets. Hold a whole class discussion after each activity to compare the answers of the different teams.

## Activity 12a

Tape the end of one short wire to the bottom of the cell and the other end to the small knob at the bottom of the bulb as shown in the following diagram.




Tape one end of the other short wire to the side of the bulb as shown in the diagram. Now touch the free end of wire A to the knob at the top of the cell. (Caution: hold the wire A by the insulated part.)

**Question 1.** What happens? Can you explain why this happens?

Write down your answers in your worksheet.

**Question 2.** When you switch on a light in your house what happens? Does your answer to Question 1 help you answer this question?

Write your answer to this question also in your worksheet.

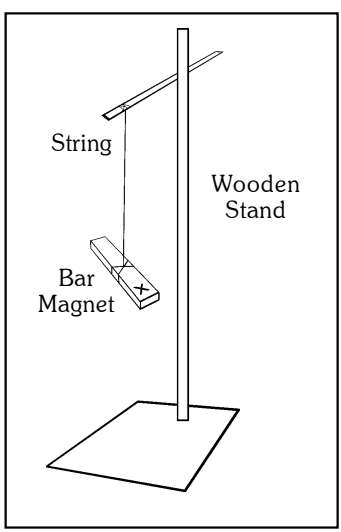
# Activity 12b

The naturally-occurring mineral magnetite consists of iron oxide, a compound of iron and oxygen. It attracts other pieces of magnetite as well as pieces of elemental iron. This property of magnetite is termed magnetism. The piece of magnetite is called a 'magnet'. If a piece of magnetite is rubbed against an iron bar, the bar also becomes a magnet. The magnet you have been given for this activity has been made in this way.

**Question 1.** How can you be sure that the magnet you have is really a magnet?

Write your answer to this question in your worksheet.

Put a mark on one end of the bar magnet for later identification. Tie a thread to the middle of the magnet and suspend it from a wooden stand as shown in the following diagram. Be sure that the magnet can rotate freely. Let it come to rest. Mark two points on the base of the stand or on




the table to show the position of the ends of the magnet when it comes to rest. Draw a line joining the two points. This line shows the alignment of the magnet when it came to rest. Now rotate the magnet in any

direction by gently pushing one end and let it come to rest. Note the alignment.

**Question 2.** Is the alignment of the magnet the second time the same as the first time, or different? Describe your results in your worksheet.

**Question 3.** Can you explain your observation? Write your explanation in your worksheet.

You might like to go on to questions 4 and 5 before answering this question. Your answer to question 5 may give you a hint about how to answer this question.

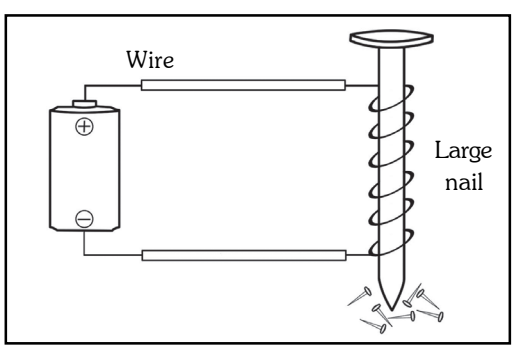
Draw a line on the table next to your stand with the suspended magnet such that one end points to the North and the other to the South.

**Question 4.** Which direction is North? Explain your method.

**Question 5.** Compare the alignment of your magnet at rest with the alignment of the North-South line you have just drawn. Describe your observation and explain it in writing in your worksheet.

## Activity 12c

Take the long piece of wire and wind it tightly around the nail as shown in the following diagram. Tape one end of the wire to the bottom of the cell. Place some pins near the tip of the nail. Now touch the other end of the wire to the knob at the top of the cell. (Precaution: hold the wire only by the covered portion. Do not touch the nail.)



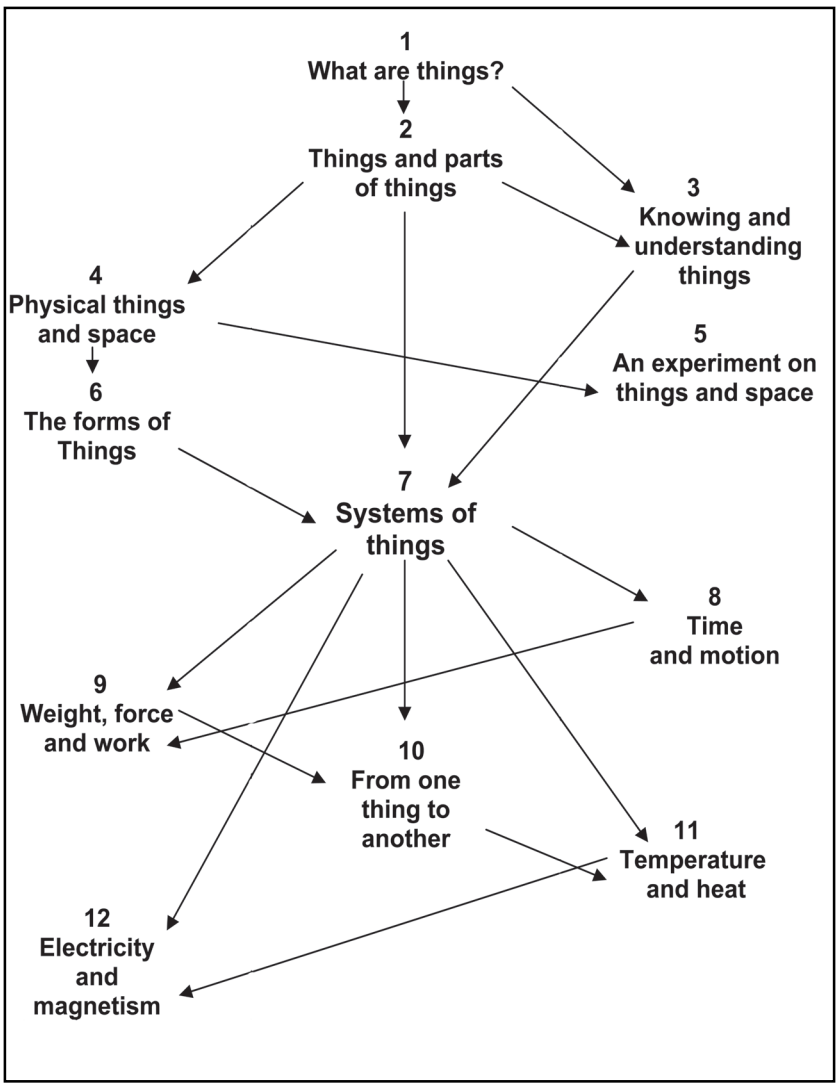
**Question 6.** What happens? Can you explain your observations? Write your observations and explanation in your worksheet.

(Note. The sub-activities in this activity are modified versions of those in the NCERT Science textbook for Grade 6, Chapters 12 and 13. [NCERT, 2006]).

# Appendix 6

## An Example of a Concept Map

This concept map is for the 12 foundational activities for the study of natural phenomena given in Appendix 5.


1
What are things?
2
Things and parts of things
3
Knowing and understanding things
4
Physical things and space
5
An experiment on things and space
6
The forms of Things
7
Systems of things
8
Time and motion
9
Weight, force and work
10
From one thing to another
11
Temperature and heat
12
Electricity and magnetism

# Appendix 7

## Ecosystems levels and their interactions

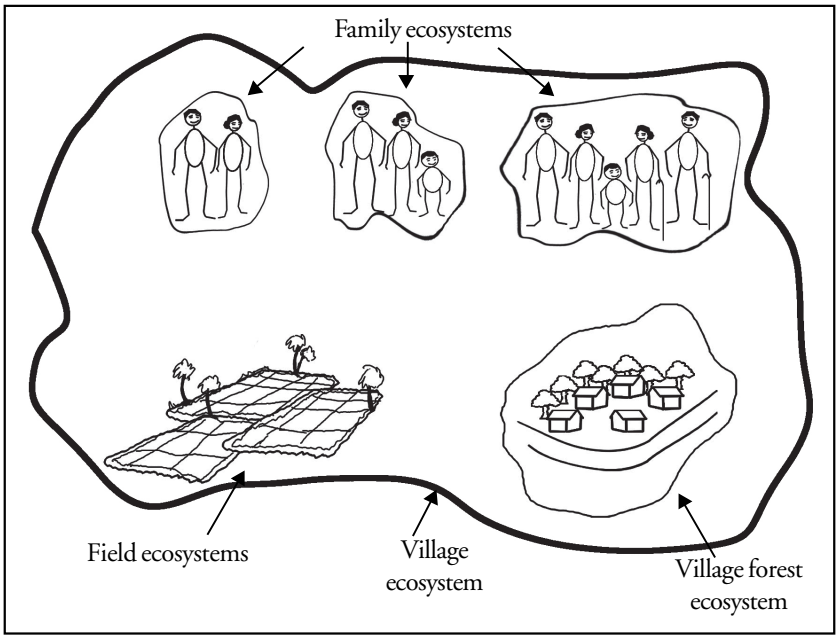
To illustrate the concept of ecosystems levels and their interactions a slightly edited version of Box 37.7 entitled '*Our Land Our Life*' from the course of the same name is reproduced below.

# Our Land Our Life

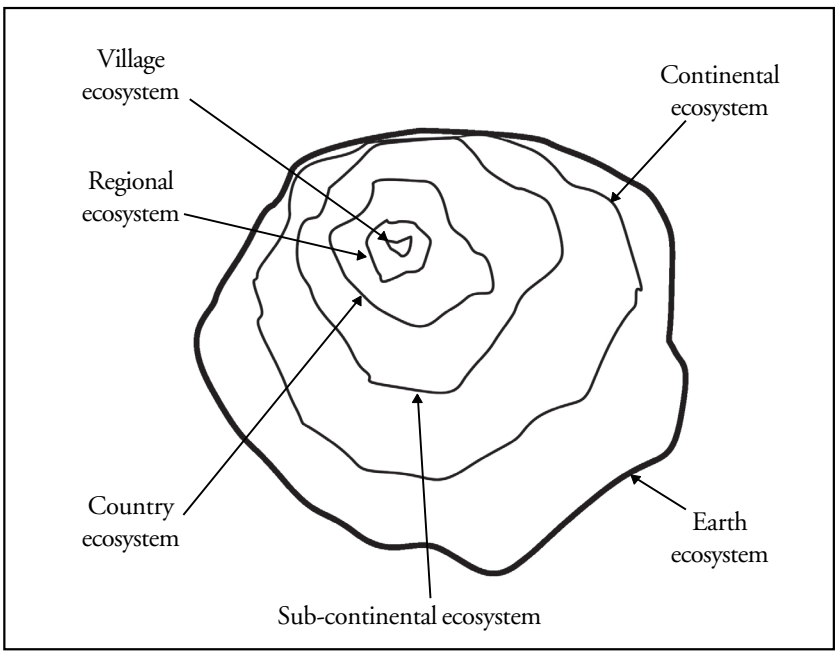
Our planet Earth is the place where we all live – human beings, animals, plants, micro-organisms, rivers, mountains, oceans and all the other things that are found on the planet. Whatever happens on planet Earth – good or bad – affects us all, wherever we live, whether in the East, in the West, North or South, in the countryside or in the city. Every being is connected to every other.

We can understand these interconnections in terms of the concept of the ecosystem. We used this concept in our study of a village. It can help us solve our current problems and manage our land, water, animals and our community to give us a secure and comfortable life.

In this box we will learn that other entities can also usefully be considered to be ecosystems. Thus a single field in our village can be thought of as an ecosystem. It contains plants, animals and decomposers which are all interdependent. A larger ecosystem comprises all the fields of a family plus their share of the village grazing land and forest, their domestic animals and the human members of the family. All the family ecosystems in turn form a village ecosystem. The relationships of these various ecosystems are shown in the following diagram. In this diagram we see that inside any ecosystem there are many smaller ecosystems. For the good health of any ecosystem, all the smaller ecosystems it contains must be healthy.



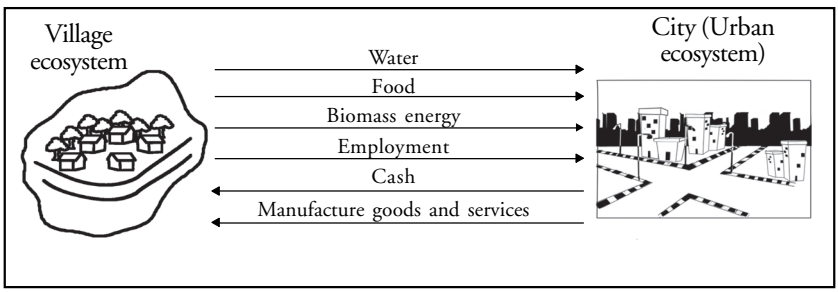
Now let us consider still larger ecosystems. A large number of villages taken together can be thought of as a regional ecosystem. For example, Uttarakhand (Boxes 18.2 and 18.3, 'Hills and plains') is a regional ecosystem. Still larger ecosystems are countries like India, comprising many smaller regional ecosystems. Then there are groups of countries like Pakistan, India, Nepal, Bhutan and Bangladesh which together form the Indian sub-continental ecosystem. Several sub-continental ecosystems together form continental ecosystems such as Asia, and all continents together, along with the oceans, form the Earth ecosystem.




Like our village ecosystem, the ecosystem of the Earth is degrading. Growing environmental problems are its indicators. For the good health of the Earth ecosystem it is essential that all the small ecosystems it contains be healthy.

Let us now take a close look at a regional ecosystem. In every region there are cities in addition to villages. The city is also an ecosystem, but it is very unlike the village ecosystem. There are many more people per hectare of land than there are in a village ecosystem, and hence most of the land in the city is covered with buildings and roads. The city does not produce all the food for its inhabitants and must import almost all its food from the

surrounding villages. As most of the land of cities is covered they are not able to collect enough water for their many inhabitants, and thus water too must be imported. (Most of the water used in cities comes from rivers.) Finally, all the energy needed by the people in a city must also be imported in the form of petroleum, coal, natural gas, electricity and fuel wood. Thus the city ecosystem is heavily dependent on the surrounding village ecosystems. But at the same time the city produces many goods and services that are needed by the village. The following diagram explains the inter-relationship between cities and villages.




If both city and surrounding villages are healthy, then the entire regional ecosystem of which they are parts will be healthy. Today, most village ecosystems and city ecosystems are sick. In this course you have learned why our village ecosystem is sick. Let us now consider the city. In what ways are our cities sick? Here are the main ones.

- Improper management of biomass. 'Wastes' from food and other biomass that flows into the city is not recycled to the land, and therefore accumulate in dumps or are put into rivers. This causes pollution of groundwater and river water. The water thus causes illness in people who drink it. If the city people were to make compost of all biomass residues (kitchen waste, human waste and factory wastes) and sell it to villages, city as well as village problems would both be solved.
- Toxic chemicals from factories are not recycled, but put into rivers, poisoning the water for fish, water plants and human beings. The recycling of all factory chemical wastes is necessary.
- The air in the city is polluted by the smoke from burning coal and petroleum in houses, factories, trucks, buses and cars. When people breathe this polluted air they become

sick. To reduce air pollution we need to burn less fuel and find other sources of energy that do not pollute the air, like solar energy.

There are several ways in which city ecosystems make village ecosystems sick, and vice versa. Here are the important ones.

- Polluted river water from the cities is used by village people to irrigate their crops, thus poisoning the land and the food that it produces. Some of this poisoned food returns to the city, and so everyone is affected.
- Polluted air from cities drifts over surrounding villages and the toxic chemicals it contains descend to the land in rain, adversely affecting the growth of crops and poisons the food produced by them.
- Chemical fertilisers and pesticides (produced in the city) poison land, ground water and food when they are used in the village. Everyone, in village and city alike, are affected.
- The living standard in many villages is going down due to the degradation of the village ecosystems. As a result village people are migrating to cities and the populations of cities is going up. Cities usually do not have adequate arrangements for all these immigrants, and both their living standard in the city and the general health of the city is adversely affected.

We have learned how to make our village ecosystem healthy and productive. If we do make them healthy, then many problems of the cities will be solved. For example, by stopping the use of agricultural chemicals we will solve the cities problems of poisonous food and water. If cities also improve the health of their ecosystems, for example, by reducing pollution and recycling biomass to the villages, the health of village ecosystems will also be improved. If everyone solves the problems of his or her own ecosystem, everyone will be healthier. The whole regional ecosystem will be healthier.

Now, if we solve the problems of our regional ecosystems, we will also be helping to solve the problems of all the larger ecosystems, up to the whole earth ecosystem. For example, if we, in our own village and city ecosystems, stop polluting air and water, and people in all village, city and regional ecosystems stop polluting air and water, then the Earths' atmosphere and oceans will no longer be polluted. Everyone in the world will benefit.

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Towards A New Educationl Protocol

M.G. Jackson

What are children learning in our schools today, and how are they learning it? Is what they are learning relevant to their needs, the needs of our society, and to the needs of the larger global society of which we are a part? What are these needs at this point in history? Is the way children are expected to learn really effective? What is our concept of learning? By not asking these questions we are driving our educational system - and our society - into ever-deepening crisis. Our efforts at fine-tuning the present system are ineffective and are creating still more problems. We need to go back to square one and then create an alternative system. The author suggests, in concrete detail, how this can be done.

M. G. Jackson has been with the Uttarakhand Environmental Education Centre, Almora for the past 25 years, involved in the creation and testing of a unique school course of local life and livelihoods, Our Land Our Life. In 2002 the Uttarakhand Department of Education integrated this course into the state school curriculum. Many years of pondering the significance of this course for school education in general has lead to the writing of this book.

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